Department of the Interior Comments on the August 2009 draft of the North Dakota Regional Haze SIP (Plan) for Implementing Section 308 (40CFR51.308) of the Regional Haze Rules

Overall Comments

The air quality staffs of the National Park Service and U.S. Fish and Wildlife Service applaud the North Dakota Division of Air Quality (NDDAQ) on drafting a well-written and comprehensive Regional Haze Plan (Plan). It covers all of the policy areas of concern to us as outlined in our August 2006 letter to the States regarding development of regional haze plans.

In particular, we appreciate the comprehensive documentation of the visibility conditions and information base for each of the Class I areas. This information provides a firm foundation for tracking visibility conditions going forward as envisioned by the regional haze rule. We agree that the three major pollutants of concern for improving visibility in North Dakota are sulfates, nitrates, and organic particulates. We commend NDDAQ for the Plan's requirements to reduce approximately 90,000 tons per year of sulfur dioxide emissions. These reductions are a substantial step in making reasonable progress toward no human-caused impairment at Class I areas. We agree with concerns raised in the Plan that emissions controls in North Dakota alone are not sufficient to achieve visibility improvement goals set out in the 1999 Regional Haze Regulations. We look forward to working with NDDAQ, other States, and our Federal partners in a cooperative effort to achieve progress in reducing all human-caused impairment in a cost-effective manner.

The Department of the Interior noted in the enclosure to its letter to NDDAQ, dated February 29, 2008, regarding assessing air quality impacts from the Gascoyne Generating Station, the three units of Theodore Roosevelt National Park (NP) are one federal mandatory class I area under the Clean Air Act. We continue to take exception to the method NDDAQ used to calculate visibility impacts and assesses progress for that Class I area under various sections of the draft Plan by treating Theodore Roosevelt NP as three separate Class I areas.

We have serious concerns regarding the determination of the emissions limits representing Best Available Retrofit Technology (BART) for nitrogen oxide controls. In addition, we have serious concerns with the exemption of the Unit #2 at the R. M. Heskett Station from BART review, and the methods used for demonstrating reasonable progress at Class I areas affected by emissions from North Dakota sources.

Section Comments

Section One: Purpose / Legal Authority

No comments

Section Two: Overview

We disagree with the statement on page 8 claiming that North Dakota has four mandatory federal Class I areas as defined under the Clean Air Act. Based on the legislation establishing Theodore Roosevelt National Park and the Clean Air Act, North Dakota has two mandatory federal Class I areas (i.e., Theodore Roosevelt NP and the Lostwood Wilderness Area). The entire acreage of Theodore Roosevelt NP is one Class I area under the Clean Air Act, and should be treated as such for all protection purposes, such as assessing for increment consumption and calculating visibility impacts.

Section Three: Plan Development and Consultation

The plan addresses the State of Minnesota's request for NDDAQ to analyze the feasibility of reducing electrical generating unit (EGU) emissions in the North Dakota to less than 0.25 pounds per million Btu (lb/MMBtu) for sulfur dioxide (SO_2) and less than 0.22 lb/MMBtu for nitrogen oxides (NO_X). While NDDAQ listed reasons why it did not believe the State of Minnesota's request was supported by assessments of impact, we request that ND supply the emission rates established by the regional haze plan from EGUs across the State so we and the public can be informed of any differences between the request from Minnesota and the final requirements of the NDDAQ plan.

The U.S. Environmental Protection Agency (EPA) will need to review any discrepancy between the Minnesota regional haze plan and the North Dakota regional haze plan during its review and approval process. In addition, we agree with NDDAQ that the EPA should address the significant contribution of international emissions, particularly from power generation in Canada, in support of NDDAQ's efforts for reasonable progress.

Section Four: Monitoring Strategy and Other Implementation Plan Requirements

We note that the language in the footnote of Table 4.1 implies that the visibility monitoring conducted under the cooperative Inter-Agency Monitoring of Protected Visual Environments (IMPROVE) system at Theodore Roosevelt NP is covering more than one Class I area. While the monitoring is at one unit, it is representative of all three units of that one Class I area.

We appreciate NDDAQ's efforts to enhance monitoring of visibility with additional collection of data. We support the ongoing efforts to collect and periodically update state-wide inventories of pollutant emissions that may contribute to the visibility impairment noted on page 24 of the Plan.

Section Five: Baseline and Natural Conditions and Uniform Rate of Progress for North Dakota Class I Areas

As previously noted, we do not agree with the statement on page 30 that North Dakota has four distinct Class I areas. We do agree that the IMPROVE data collected at Theodore Roosevelt NP sufficiently tracks the long-term visibility conditions across the entire park and can be used for implementing the requirements of the regional haze rule.

Section Six: Sources of Visibility Impairment in North Dakota Class I Areas

We appreciate the presentation of the Western Regional Air Partnership (WRAP) assessment of sources of visibility impairment at the two North Dakota Class I areas. In particular, Table 6.6 is a useful summary of North Dakota's contribution to impairment listed by component of light extinction. This forms a baseline to compare projected conditions in the reasonable progress section of the Plan. We ask that NNDAQ clarify in the narrative that the sulfate and nitrate results are based on regional modeling using the CAMx-PSAT source apportionment tool, while the analyses of weighted emissions potential for organic carbon (OC), elemental carbon (EC), and particulate matter (PM) are based on emissions and residence time, not modeling. Figures 6.1, 6.2, 6.7, and 6.8 would be more informative if they also included 2018 results for sulfate and nitrate as is shown in the other figures for OC, EC, and PM.

Section Seven: Best Available Retrofit Technology (BART)

General Comments on BART

We appreciate this opportunity to comment upon the North Dakota Department of Health's (NDDAQ's) proposal for Best Available Retrofit Technology (BART) for the seven Electric Generating Units (EGUs) in North Dakota that it has identified as being subject to BART. We are impressed with the effort and expertise that went into this effort, and we are pleased that NDDAQ is proposing major reductions in the visibility-impairing pollutants sulfur dioxide (SO_2), and nitrogen oxides (NO_x). We are especially appreciative of the approximately 90,000 tons per year reduction in sulfur dioxide emissions from application of BART in the draft Plan. However, we believe that additional reductions can be achieved under the BART program. Based on our analyses summarized below and discussed in detail in the enclosed documents, we believe that additional reductions beyond those identified by NDDAQ are reasonable. Our comments below address the five-step BART process described by EPA's BART Guidelines and documented by NDDAQ.

As noted, we recognize that NDDAQ and the affected sources expended considerable effort in developing these analyses over several years and generated large amounts of useful information. However, it would be helpful, when NDDAQ advances this process into the public arena, if the NDDAQ BART determinations could provide more guidance as to the origins of the data used in their analyses. In our analyses of the data provided by NDDAQ and the sources, we generated several electronic files that we would be pleased to share with NDDAQ if those files could assist in providing a clearer understanding of this complex BART process.

Purpose of the BART Program

The core purpose of the BART program is to improve visibility in our Class I areas. BART is not necessarily the most cost-effective solution. Instead, BART represents a broad consideration of technical, economic, energy, and environmental (including visibility improvement) factors. We believe that it is essential to consider both the degree of visibility improvement in a given Class I area as well as the cumulative effects of improving visibility across all of the Class I areas affected.

Five-Step BART Process

Step 1: IDENTIFY AVAILABLE RETROFIT CONTROL TECHNOLOGIES
Except for Great River Energy's (GRE's) analysis for NO_x from Coal Creek, all of the other SO_2 and NO_x analyses included a reasonable suite of options.

We also have some general comments that apply to all of the PM_{10} analyses. We believe that the BART analyses are deficient in that they neither address upgrades to the existing Electrostatic Precipitators (ESPs) or propose limits that realistically reflect the capabilities of those existing ESPs, as well as the proposed new baghouses, to control filterable PM. EPA's BART Guidelines (Guidelines) advise:

- "...it is important to include control options that involve improvements to existing controls and not to limit the control options only to those measures that involve a complete replacement of control equipment."
- "...for retrofitting existing sources in addressing BART, you should consider ways to improve the performance of existing control devises, particularly when a control device is not achieving the level of control that other similar sources are achieving in practice with the same device. For example, you should consider requiring those sources with electrostatic precipitators (ESPs) performing below currently achievable levels to improve their performance."

Although all of these sources have ESPs in place, none of them except Stanton Unit #1 is currently achieving a level of performance equivalent to the 0.015 lb/mmBtu proposed for ESPs at sources such as Peabody's Thoroughbred and LG&E's Trimble County projects in Kentucky. Furthermore, EPA has recently issued a permit limiting the Desert Rock facility to 0.010 lb/mmBtu filterable PM_{10}, new baghouses are being permitted at 0.009 – 0.012 lb/mmBtu in Virginia (Virginia Hybrid Energy Center) and Wyoming (Dry Fork, WYGEN 3), and ND DOH proposed to permit the Gascoyne project at 0.012 lb/mmBtu. Instead, the limits on filterable PM_{10} proposed by NDDAQ are two – to – three times the emission rates measured by stack testing and cited by NDDAQ. While we understand that a certain "safety margin" must be allowed, we believe that the BART limits should be set to encourage continued good operation and maintenance of the pollution control equipment.

Step 2: ELIMINATE TECHNICALLY INFEASIBLE OPTIONS
This step was handled appropriately.

Step 3: EVALUATE EFFECTIVENESS OF REMAINING CONTROL TECHNOLOGIES

The ability of SCR to reduce emissions, as assumed by NDDAQ, was inconsistent and sometimes underestimated. For example, for the LNB/OFA+SCR option, GRE, Basin Electric Power Cooperative (BEPC), and NDDAQ sometimes assumed 0.07 lb/mmBtu for all averaging periods. However, for example, the WY Department of Environmental Quality has issued permits for new EGUs requiring that they meet 0.05 lb/mmBtu over averaging periods of 24-hours[1] and 30-days.[2] Furthermore, EPA's Clean Air Markets (CAM) data (Appendix A) and vendor guarantees[3] show that SCR can typically meet 0.05 lb/mmBtu (or lower) on an annual average basis. GRE, BEPC, and NDDAQ have not provided any documentation or justification to support the higher values used in their analyses. Our review of operating data (Appendix A) suggests that a NO_X limit of 0.06 lb/mmBtu is appropriate (with an adequate "safety-margin") for LNB/OFA+SCR for a 30-day rolling average, and 0.07 lb/mmBtu for a 24-hour limit and for modeling purposes, but a lower rate (e.g., 0.05 lb/mmBtu or lower) should be used for annual average and annual cost estimates. When the annual NO_x reductions are underestimated, the cost-effectiveness of the control option is negatively affected.

Step 4: EVALUATE IMPACTS AND DOCUMENT RESULTS

The cost of SCR was consistently overestimated. EPA's BART Guidelines recommend use of the OAQPS Control Cost Manual. Neither Minnkota Power Cooperative (Minnkota), GRE, BEPC, nor NDDAQ provided justification or documentation for their cost estimates. We were not provided with any vendor estimates or bids, and none used the recommended Control Cost Manual. This resulted in much-higher SCR costs than suggested by available literature (see Appendix B cost summaries) which shows SCR costs ranging from \$50 - \$267/kW. As recommended by the BART Guidelines, we applied the OAQPS Control Cost Manual to the EGUs and derived costs that fell within the Appendix B cost-survey range. As a result, we believe that capital and annual costs are overestimated by NDDAQ.

According to EPA's BART Guidelines, "the basis for equipment cost estimates should be documented, either with data supplied by an equipment vendor (i.e., budget estimates or bids) or by a referenced source (such as the OAQPS Control Cost Manual, Fifth Edition, February 1996, 453/B-96-001). In order to maintain and improve consistency, cost estimates should be based on the OAQPS Control Cost Manual, where possible. The Control Cost Manual addresses most control technologies in sufficient detail for a BART analysis. The cost analysis should also take into account any site-specific design or other conditions identified above that affect the cost of a particular BART technology option."

[1] Basin Electric—Dry Fork

[2] WYGEN3

[3] Minnesota Power has stated in its Taconite Harbor BART analysis that "The use of an SCR is expected to achieve a NO_X emission rate of 0.05 lb/mmBtu based on recent emission guarantees offered by SCR system suppliers."

EPA's belief that the Control Cost Manual should be the primary source for developing cost analyses that are transparent and consistent across the nation and provide a common means for assessing costs is further supported by this November 7, 2007, statement from EPA Region 8 to NDDAQ:

> The SO_2 and PM cost analyses were completed using the CUECost model. According to the BART Guidelines, in order to maintain and improve consistency, cost estimates should be based on the OAQPS Control Cost Manual. Therefore, these analyses should be revised to adhere to the Cost Manual methodology.

We are especially concerned about the lack of justification and support for the estimates of costs for reheating the exhaust gas streams to facilitate addition of "tail-end" SCR. Reheat costs are a critical issue affecting the economic feasibility of SCR, and, even in those cases where some data were presented (by GRE), it was still not adequate for us to be able to understand the assumptions that formed the bases for the natural gas usage estimates. Furthermore, we are concerned that the costs of catalyst, ammonia, electricity, and natural gas were inflated beyond what we typically see, or what is projected by the Energy Information Administration (EIA) with respect to future natural gas prices. Finally, we are concerned that this critical cost was simply scaled from a few examples and applied to other SCR analyses—we believe that it deserves individual analyses specific to each case.

Step 5: VISIBILITY IMPROVEMENT DETERMINATION

We believe that it is appropriate to consider both the degree of visibility improvement in a given Class I area as well as the cumulative effects of improving visibility across all of the Class I areas affected. It simply does not make sense to use the same metric to evaluate the effects of reducing emissions from a BART source that impacts only one Class I area as for a BART source that impacts multiple Class I areas. And, it does not make sense to evaluate impacts at one Class I area, while ignoring others that are similarly significantly impaired. If we look at only the most-impacted Class I area, we ignore that the other Class I areas are all suffering from impairment to visibility "caused"[4] by the BART source. It follows that, if emission from the BART source are reduced, the benefits will be spread well beyond only the most impacted Class I area, and this must be accounted for.

The BART Guidelines represent an attempt to create a workable approach to estimating visibility impairment. As such, they require several assumptions, simplifications, and shortcuts about when visibility is impaired in a Class I area, and how much impairment is occurring. The Guidelines do not attempt to address the geographic extent of the impairment, but assume that all Class I areas are created equal, and that there is no difference between widespread impacts in a large Class I area and isolated impacts in a small Class I area. To address the problem of geographic extent, we have been looking at the cumulative impacts of a source on all Class I areas affected, as well as the cumulative benefits from reducing emissions. While there are certainly more sophisticated

[4] EPA defines a source with an impact greater than one deciview as "causing" impairment.

approaches to this problem, we believe that this is the most practical, especially when considering the modeling techniques and information available.

We are concerned that NDDAQ has not adequately considered the visibility benefits of the control strategies it evaluated. In many cases, instead of evaluating a candidate BART strategy by determining the visibility improvement that would result from that particular strategy versus a "standard" baseline (e.g., the proposed SO_2 control options), the only analyses of visibility improvements were of the incremental differences between competing BART options. In most cases, were able to develop estimates of the actual improvements for a given strategy, but that was a very difficult process that required many assumptions and extrapolations that fail the test of "transparency."

The State's BART protocol was developed and approved by EPA Region 8 several years ago. Although we honor approved protocols from that time period, our modeling results indicate that use of current methods produces estimates of visibility impairment and improvement that are usually greater than the estimates provided by NDDAQ and the BART sources. For example, we evaluated the impacts of emissions from Leland Olds Station (LOS) Unit #2 using both the EPA-recommended Pasquill-Gifford (P-G) atmospheric stability approach and the turbulence-based approach used in ND. We first estimated the impacts from baseline emissions, but included condensable PM_{10} emissions using estimates derived from EPA's Compilation of Air Pollutant Emission Factors (AP-42). Next, we established a new "baseline" based upon emissions from LOS #2 after application of the proposed wet scrubber. Finally, we modeled the options in which Selective Non-Catalytic Reduction (SNCR) and SCR were added to the wet scrubber and compared each of those results to the "scrubber-only" results. We found that our modeling results (see Appendix C) consistently predicted significantly higher impacts and that the benefits of reducing NO_x were also substantially higher (by as much as a factor of two for addition of SCR to LOS #2). This has major implications for a program aimed at improving visibility.

BART DETERMINATIONS

It appears to be more beneficial to reduce NO_x than to reduce SO_2 in this cool climate. However, by placing more emphasis upon cost-per-ton ($/ton) of pollutants removed than on visibility improvement, the advantages of reducing NO_x versus SO_2 are overlooked if both are measured with the same $/ton yardstick. For this reason, we recommend that the primary emphasis should be placed upon the cost – per – deciview ($/dv) of improvement.

Compared to the typical control cost analysis in which estimates fall into the range of $2,000 - $10,000 per ton of pollutant removed, spending millions of dollars per deciview to improve visibility may appear extraordinarily expensive. However, our compilation[5] of BART analyses across the U.S. reveals that the **average cost per dv proposed by either**

[5] http://www.wrapair.org/forums/ssjf/bart.html

a state or a BART source is $9 - $20 million,[6] with a maximum of almost $50 million per dv proposed by Colorado at the Martin Drake power plant in Colorado Springs. A comparison of the cost/dv values resulting from NDDAQ's BART proposals shows that addition of Advanced Separated Over-Fire Air (ASOFA) and SNCR to LOS #1 would result in cost-effectiveness values of $27.3 million/dv at the most-impacted Class I area and $13.6 million/dv when the benefits to both Class I areas are considered. Likewise, the addition of combustion controls and SNCR at Stanton #1 would result in cost-effectiveness values of $33.1 - $41 million/dv at the most-impacted Class I area and $16.9 – $20.9 million/dv when the benefits to both Class I areas are considered. We suggest that NDDAQ should reconsider its other BART determinations in view of these cost-effectiveness values it has effectively accepted.

Another concern with the visibility analyses presented by NDDAQ is the over-emphasis on the incremental improvements to visibility resulting from SCR. NDDAQ calculated only the incremental improvement in visibility resulting from addition of some potential controls. Although incremental benefits are an appropriate consideration, they should not become the sole basis for a BART decision. NDDAQ should have presented the total visibility improvement that would result from a control option instead of presenting only the incremental improvement.

For several units, ND DOH is proposing alternative sulfur dioxide (SO_2) limits that are similar to the presumptive BART limits because they allow a source to choose between a limit in terms of pounds of emissions per million Btu of heat input, or percent reduction of that pollutant. While EPA presented its BART Guidelines for SO_2 in that format, we do not believe that it was EPA's intention to allow the source to choose the more favorable limit. By definition, BART represents the highest degree of control that meets the five-factor test. Where ND DOH has determined that a lb/mmBtu limit is reasonable, it should require that that limit be met. Similarly, where ND DOH has determined that a percent reduction limit is reasonable, it should require that that limit be met. If both limits are determined to be reasonable, then to allow the source to choose only one clearly does not represent the most stringent reasonable degree of control. Therefore, where ND DOH has proposed alternative limits, both should be required.

There is also a fundamental problem with setting only a percent-reduction limit on SO_2 emissions. If fuel sulfur content increases, emissions can increase correspondingly. Unless sulfur content is limited, or a cap is placed on mass emissions (e.g., lb/hr, tons/yr as proposed by Wyoming, for example), the actual amount of SO_2 emitted is unlimited.

In addition to an absence of any evaluation of upgrading the existing PM control equipment, it appears that ND DOH is not following EPA guidance to consider more stringent emission rates in setting permit limits:

> "If you find that a BART source has controls already in place which are the most stringent controls available (note that this means all possible improvements to any control

[6] For example, PacifiCorp has stated in its BART analysis for its Bridger Unit #2 that "The incremental cost effectiveness for Scenario 1 compared with the baseline for the Bridger WA, for example, is reasonable at $580,000 per day and $18.5 million per deciview."

> devices have been made), then it is not necessary to comprehensively complete each following step of the BART analysis in this section. As long as these most stringent controls available are made federally enforceable for the purpose of implementing BART for that source, you may skip the remaining analyses in this section."

We recommend that ND DOH establish permit limits that reflect the capabilities of the BART technology to control filterable PM.

Primary Conclusions & Recommendations

Our analyses of the information provided by NDDAQ lead us to the following preliminary conclusions and recommendations (as discussed in detail in the following documents):

- The loss of ash sales at Coal Creek is a critical, but unsupported, cost of adding SNCR or SCR. If ash sales are not adversely affected, addition of SNCR becomes a reasonable BART selection.
- Space constraints likely justify selection of the spray-dry/fabric filter option at Stanton #1.
- The cost of reheating stack gas to facilitate addition of SCR is a critical factor in the feasibility of that option and must be better-documented, along with better justification for the costs of SCR itself.
- The differing modeling approaches have a significant impact upon the visibility modeling results and should be evaluated and resolved.
- More emphasis should be placed upon the cumulative visibility benefits that could be derived from the BART program.
- SCR may become a more viable option when these issues of effectiveness, cost, and benefits are resolved.
- NDDAQ should consistently and transparently determine and apply an objective approach to its BART determinations.

Heskett Exemption

In Section 7.3.4, the Plan describes the steps taken that result in excluding the Montana Dakota Utilities R.M. Heskett Unit No. 2 from BART review. We are aware of the modeling protocol used by the WRAP and of a revised protocol developed from discussions between the U.S. EPA Region 8 staff and the NDDAQ staff regarding certain sources in the State. After the Heskett Unit No. 2 failed the exclusion modeling analysis under the revised North Dakota protocol, ENSR Corporation developed a third protocol for Heskett Unit No. 2. We have no record of receiving or reviewing the third modeling protocol conducted by ENSR Corporation for the Heskett facility. Our concerns with the work performed by ENSR Corporation center on the use of a 1 kilometer grid, and that the calculation for maximum impact separates Theodore Roosevelt NP into three separate Class I areas. Based on agreed-upon methods and its baseline emissions, we believe that Heskett Unit No. 2 is subject to BART requirements.

The draft Plan cites a reduction of Heskett Station's emissions of sulfur dioxide from a baseline of 2400 tons per year to a rate of 1660 tons per year within five years of Plan approval by the EPA. This reduction is a 31 percent reduction not the 70 percent reduction claimed in the draft Plan. This BART-like requirement is not based on assessing the full range of engineering options appropriate to Heskett Unit No. 2, nor is it consistent with the requirements of a voluntary reduction that would reduce the impact of the BART-eligible unit below the threshold that triggers BART requirements. To be accepted as a voluntary reduction, the source's emission limit would need to be in place upon submission of the Plan to the EPA.

Specific Comments on BART Determinations

Great River Energy (GRE) Coal Creek Units #1 & #2:

Great River Energy (GRE) operates Coal Creek Units #1 & #2 near Underwood, North Dakota. Both units are tangentially-fired with lignite from an adjacent mine and are rated at 550 MW (gross) output. Current emission control equipment consists of wet limestone scrubbers, Low-NO_x Burners (LNB) and Separated Overfire Air (SOFA), and Electrostatic Precipitators (ESPs). Although each unit has a capacity greater than 200 MW at a facility with a total capacity greater than 750 MW, presumptive BART limits only apply for nitrogen oxide (NO_x) because there are existing sulfur dioxide (SO_2) controls on both units at the facility.

Out of 1,228 power plants in EPA's Clean Air Markets (CAM) database in 2008, the Coal Creek plant ranked #104 for SO_2 at 23,142 tons and #101 for NO_x at 9,457 tons. According to modeling results provided by GRE, emissions from Coal Creek cause 2.9 dv of impairment in visibility at Theodore Roosevelt NP and 5.4 dv cumulatively when Lostwood WA is included. Without additional emission controls, SO_2 emissions are expected to almost double by 2019 due to deteriorating lignite quality (higher sulfur, lower heating value).

A. Sulfur Dioxide

Step 1: Identify All Available Technologies
We agree that NDDAQ has chosen a reasonable suite of options.

Step 2: Eliminate Technically Infeasible Options
We agree with NDDAQ's selection of technically feasible options.

Step 3: Evaluate Control Effectiveness of Each Remaining Control Technology
We agree with NDDAQ's estimates of control effectiveness.

Step 4: Evaluate Impacts and Document Results
While the proposed costs ($139/kW) for upgrading the scrubbers (and eliminating the flue gas by-pass) appear high when compared to similar projects in MN, ND and WY,[7] they have been accepted by both GRE and NDDAQ.

[7] Sherburne Country 1 MN, Bridger and WYODAK in WY, and MR Young in ND.

NDDAQ Estimates for Coal Creek Wet Scrubber Upgrade (each)

Total Capital Cost:	$ 76,222,700
Total Capital Cost $/kW):	$ 139
O&M Cost:	$ 2,090,296
Total Annual Cost:	$ 11,520,000
Cost per Ton	$ 555

Step 5: Evaluate Visibility Results

By comparing scenarios provided by GRE in which NO_x is constant but SO_2 changes, we have estimated that the proposed scrubber upgrades will each result in an approximately one dv improvement in visibility at Theodore Roosevelt NP and 1.9 dv cumulatively when Lostwood WA is included.

Determine BART

NDDAQ is proposing upgrading the existing wet scrubber to limit SO_2 emissions to 0.15 lb/mmBtu **or** 95% reduction on a 30-day rolling average basis. This results in cost-effectiveness values of $11.0 million per dv at Theodore Roosevelt NP and $5.9 million per dv cumulatively when Lostwood WA is included.

Scrubber Upgrade Cost-effectiveness

Annual Cost ($million)	$ 11.52
Visibility Improvement at TRNP (dv)	1.04
Cost-Effectiveness ($million/dv)	$ 11.06
Cumulative Visibility Improvement (dv)	1.94
Cost-Effectiveness ($million/dv)	$ 5.94

Because NDDAQ has proposed no absolute limits on emissions, the proposed BART limits would result in a 72% reduction in current SO_2 emissions on a lb/mmBtu basis and a 72% reduction on a tons-per-year basis.

Sulfur content of the coal was the primary constituent of concern because SO_2 emissions are directly related to the amount of sulfur in the coal and are not as related to equipment design. NDDAQ estimated that future delivered coal will have a maximum annual average sulfur content of approximately 1.10%.

Instead, we recommend 0.15 lb/mmBtu **and** 95% reduction on a 30-day rolling average basis because NDDAQ has determined that both of these levels are reasonable. Even if coal quality deteriorates to the anticipated worst-case (1.49 lb/mmBtu), 90% control would still meet the 0.15 lb/mmBtu limit.

B. Nitrogen Oxides

Step 1: Identify All Available Technologies
We believe that NDDAQ should have included a combination of combustion controls (e.g., Low-NO_X Burners, Over-Fire Air) coupled with Selective Catalytic Reduction (SCR) to its suite of options.

Step 2: Eliminate Technically Infeasible Options
Except as noted above, we agree with NDDAQ's selection of technically feasible options.

Step 3: Evaluate Control Effectiveness of Each Remaining Control Technology
Based on the 0.22 lb/mmBtu NO_X baseline emission rate, outlet emissions projected by NDDAQ for SCR at 0.07 lb/mmBtu represent only a 80% SCR control efficiency and a reduction of 4,286 tpy. (This is much lower than other analyses[8] in which NDDAQ has assumed 88% - 90% for SCR control effectiveness.) We believe that a combination of combustion control plus SCR can achieve 90% NO_x removal as opposed to the 80% estimated by NDDAQ for SCR alone.

Step 4: Evaluate Impacts and Document Results
NDDAQ estimated the following costs for LNB + SOFA:

NDDAQ Estimates for Coal Creek LNB+SOFA

Total Capital Cost:	$	5,260,000
Total Capital Cost $/kW):	$	10
O&M Cost:	$	7,942
Total Annual Cost:	$	660,000
Cost per Ton	$	411

In its evaluations of SNCR and SCR, GRE included $13.75 million (per boiler) "sunk costs" for its ash handling infrastructure, and $14.4 million (per boiler) annual costs that represent lost ash sales revenue. It is inappropriate to include sunk costs in future decision-making.

If true, the loss of ash sale revenue and the consequent need to pay for ash disposal represent a major portion of the total $22.9 million annual operating cost for SNCR, and the total $37.1 million annual operating cost for SCR, so this issue becomes the critical factor affecting the cost-effectiveness of these technologies. However, NPS can find no examples of cases where ammonia contamination has resulted in lost ash sales, so we are presenting estimates that adjust the NDDAQ costs to eliminate the sunk costs as well as the costs associated with lost ash sales (as well as another $2 million per boiler annual cost for ash disposal). Our $1,072 cost was derived from applying the EPA Control Cost Manual. (Please see Appendix B.)

[8] Leland Olds #2, MR Young #1 & #2, Stanton #1

Coal Creek SNCR Cost Estimates

Cost	NDDAQ	NDDAQ (adj)	NPS
Total Capital Cost:	$ 19,909,069	$ 6,159,069	$ 6,862,904
Total Capital Cost $/kW):	$ 36	$ 11	$ 12
O&M Cost:	$ 21,231,102	$ 4,828,001	$ 2,265,878
Total Annual Cost:	$ 22,900,000	$ 6,496,899	$ 2,913,687
Cost per Ton	$ 8,551	$ 2,426	$ 1,072

NDDAQ has estimated a total annual cost for low-dust SCR with reheat at $56.2 million. Of that total, $19.2 million is a result of installing and operating a natural gas-fired gas reheating system to bring the flue gas back up to a temperature suitable for efficient SCR operation. The result of NDDAQ's assumptions is that SCR would cost over $13,000 per ton, which it deemed to be excessively costly.

Coal Creek SCR Cost Estimates

Cost	NDDAQ	NPS
Total Capital Cost:	$ 84,110,657	$ 41,718,972
Total Capital Cost $/kW):	$ 153	$ 76
O&M Cost:	$ 49,011,624	$ 11,389,572
Total Annual Cost:	$ 56,150,000	$ 15,327,547
Cost per Ton	$ 13,102	$ 3,722

NPS eliminated the sunk costs and the costs associated with lost ash sales and applied the EPA Control Cost Manual (Please see Appendix B.) to produce a much lower $3,722 per ton estimate for SCR.

Step 5: Evaluate Visibility Results

By comparing scenarios in which SO_2 is constant but NO_x changes, we have estimated that visibility improves at Lostwood WA 0.00006 dv per ton of NO_x removed, and 0.00012 dv/ton cumulatively. The visibility improvement values shown in the tables below are based upon those estimates.

Determine BART

NDDAQ is proposing LNB + SOFA at 0.17 lb/mmBtu on a 30-day rolling average basis.

LNB + SOFA Cost-effectiveness	NDDAQ
Annual Cost ($million)	$ 0.66
Visibility Improvement at Lostwood WA (dv)	0.10
Cost-Effectiveness ($million/dv)	$ 6.58
Cumulative Visibility Improvement (dv)	0.19
Cost-Effectiveness ($million/dv)	$ 3.52

NDDAQ rejected SNCR on the basis of excessive cost. However, when we adjusted the NDDAQ estimates to eliminate the effects of sunk costs and lost ash sales, the resulting cumulative cost-effectiveness of $20.1 million per dv becomes marginally cost-effective. NDDAQ should reevaluate SNCR in more depth.

SNCR Cost-effectiveness	**NDDAQ**	**NDDAQ (adj)**	**NPS**
Annual Cost ($million)	$ 22.90	$ 6.50	$ 2.91
Visibility Improvement at Lostwood WA (dv)	0.17	0.17	0.17
Cost-Effectiveness ($million/dv)	$ 137.02	$ 38.87	$ 17.18
Cumulative Visibility Improvement (dv)	0.31	0.31	0.32
Cost-Effectiveness ($million/dv)	$ 73.30	$ 20.80	$ 9.19

We estimate SNCR cost-effectiveness at $17.2 million per dv at Lostwood WA and $9.2 million per dv on a cumulative basis. We believe these costs are reasonable.

NDDAQ rejected SCR on the basis of excessive cost. When we adjusted the NDDAQ estimates to eliminate the effects of sunk costs and lost ash sales and applied the methods from the EPA Control Cost Manual, the results were still not cost-effective.

SCR cost-effectiveness	**NDDAQ**	**NPS**
Annual Cost ($million)	$ 56.15	$ 15.33
Visibility Improvement at Lostwood WA (dv)	0.27	0.26
Cost-Effectiveness ($million/dv)	$ 209.93	$ 59.64
Cumulative Visibility Improvement (dv)	0.50	0.48
Cost-Effectiveness ($million/dv)	$ 112.31	$ 31.91

Conclusions & Recommendations

- NDDAQ is proposing upgrading the existing wet scrubber to limit SO_2 emissions to 0.15 lb/mmBtu **or** 95% reduction on a 30-day rolling average basis. The proposed scrubber upgrades will each result in an approximately one dv improvement in visibility at Theodore Roosevelt NP and 1.9 dv cumulatively when Lostwood WA is included.
- We commend NDDAQ for the proposed new wet scrubber, but recommend that the limits require **both** 95% control **and** 0.15 lb/mmBtu, as well as specific caps on emissions.
- NDDAQ is proposing LNB + SOFA at 0.17 lb/mmBtu on a 30-day rolling average basis as BART for NO_X. As a result, visibility would improve by 0.10 dv at Lostwood and 0.19 dv cumulatively.
- NDDAQ has underestimated the effectiveness of SCR at only 80% control efficiency.
- NDDAQ has overestimated the costs of SNCR and SCR Many of the costs associated with SNCR and SCR presented by GRE and NDDAQ were not supported by GRE's documentation. Costs associated with lost ash sales and ash disposal were not adequately justified. More reliance should be placed upon use

of the EPA Control Cost Manual when the source fails, as GRE did, to provide sufficient supporting documentation of its costs. Our application of the EPA Control Cost Manual yielded much lower cost estimates for SNCR and SCR.

- NDDAQ has not adequately considered the visibility benefits of the control strategies it evaluated.
- NPS' analysis of addition of SNCR indicates that visibility would improve by 0.17 dv at Lostwood and 0.32 dv cumulatively. This yields a cost-effectiveness of $17.2 million per dv at Lostwood WA and $9.2 million per dv cumulatively when Theodore Roosevelt NP is included, which we believe to be reasonable based upon BART determinations and proposals we have seen nationwide to date.
- NPS' estimates for addition of SNCR show cost-effectiveness values below the $17 - $21 million per cumulative dv that NDDAQ accepted for adding SNCR at Stanton #1. Considering that the BART program is intended to improve visibility, it follows that any cost-effectiveness value below the costs per dv accepted by NDDAQ at Leland Olds #1 and Stanton should also be acceptable at Coal Creek.
- We conclude that SNCR is BART for control of NO_X emissions from GRE Coal Creek Units #1 and #2.

Great River Energy (GRE) Stanton Station Unit #1

Great River Energy (GRE) operates the 256 MW Stanton Station near Stanton, ND. The plant is located about 150 km from Theodore Roosevelt National Park NP, a Class I area administered by the National Park Service.[9] Out of 1,228 power plants in EPA's Clean Air Markets (CAM) database in 2008, the Stanton plant ranked #335 for sulfur dioxide (SO_2) at 2,873 tons and #324 for nitrogen oxides (NO_x) at 2,033 tons.

Stanton Unit #1

Unit #1 is a front-wall-fired boiler that burns sub-bituminous coal from the Powder River Basin (PRB) and local lignites. Unit #1 began operation in 1966 and is rated at 1,800 mmBtu/hr heat input. Unit #1 is equipped with Low-NO_x Burners (LNB) and an Electrostatic Precipitator (ESP) to control particulate matter (PM). Out of 3,558 units in EPA's CAM database in 2008, Stanton #1 ranked #667 for SO_2 at 2,726 tons and #696 for NO_x at 1,174 tons. According to modeling results provided by GRE, emissions from Stanton #1 cause 1.3 dv of impairment in visibility at Theodore Roosevelt NP and 2.4 dv cumulatively when Lostwood WA is included. Therefore, it is subject to Best Available Retrofit Technology (BART).

A. Sulfur Dioxide

NDDAQ has assumed that future uncontrolled SO_2 emissions may increase by 33% due to deteriorating coal quality.

Step 1: Identify All Available Technologies

We agree that NDDAQ has chosen a reasonable suite of options.

[9] The Lostwood National Wildlife Refuge, a Class I area administered by the U.S. Fish & Wildlife Service, is located about 150 km from the Stanton plant.

Step 2: Eliminate Technically Infeasible Options

We agree with NDDAQ's selection of technically feasible options. However, we also agree with NDDAQ that applying a wet scrubber at this site has so many adverse environmental consequences[10] that we will not consider that option further, and will confine our review to the Spray-Dryer/Fabric Filter (SD/FF) option.

Step 3: Evaluate Control Effectiveness of Each Remaining Control Technology

NDDAQ has estimated that a new SD/FF will reduce SO_2 emissions by 90% for both lignite and PRB coal combustion. We believe that higher control efficiency is warranted for the both the lignite and PRB sub-bituminous coal scenarios. For example, a SD/FF on 2.4 lb/mmBtu lignite or 1.6 lb/mmBtu PRB sub-bituminous coal should be capable of at least 93% control and achieve an emission limit of 0.09 lb/mmBtu on a 30-day rolling average basis.[11] Because the larger Stanton Unit #10 also located at this site is achieving less 0.06 lb/mmBtu on an annual basis (presumably burning PRB coal) using the same SD/FF technology proposed for Stanton #1, NDDAQ should explain why a newer installation of that technology at Stanton #1 cannot perform as well, at least on PRB coal.

Step 4: Evaluate Impacts and Document Results

The proposed cost ($423/kW) for adding the 90% efficient SD/FF appears reasonable. The result of NDDAQ's assumptions is that the new SD/FF would cost $1,330 per ton while burning lignite, and $2,006 per ton while burning PRB coal, which NDDAQ deemed reasonable. It is likely that increasing the SD/FF efficiency to achieve 0.09 lb/mmBtu would be even more cost-effective on a $/ton basis.

Stanton #1 SD/FF Cost Summary

	lignite	PRB
Total Capital Cost:	$ 79,514,000	$ 79,514,000
Total Capital Cost $/kW):	$ 423	$ 423
O&M Cost:	$ 4,071,674	
Total Annual Cost:	$ 11,220,000	$ 11,220,000
Cost per Ton	$ 1,330	$ 2,006

Step 5: Evaluate Visibility Results

Based upon data supplied by GRE and by NDDAQ, we have estimated that, when burning lignite, the proposed new 90% efficient SD/FF will result in an approximately 0.8 dv improvement in visibility at Theodore Roosevelt NP and 1.5 dv cumulatively when Lostwood WA is included. When burning PRB coal, the proposed new 90% efficient SD/FF will result in an approximately 0.5 dv improvement in visibility at Theodore Roosevelt NP and 1.0 dv cumulatively when Lostwood WA is included. Our review of NDDAQ visibility modeling yields a SO_2 control-effectiveness factor for the

[10] We are especially concerned about the problems associated with disposal of the wet scrubber sludge in this space-limited site adjacent to the Missouri River.

[11] Please see the entry in Appendix D for the permit issued by Wyoming to Black Hills Power for its WYGEN 3 project.

new SD/FF of 0.00009 dv/ton at Theodore Roosevelt NP and 0.00018 dv/ton cumulatively when Lostwood WA is included.[12]

Determine BART

NDDAQ is proposing addition of a new SD/FF to limit SO_2 emissions while burning lignite to 0.24 lb/mmBtu **<u>or</u>** 90% reduction on a 30-day rolling average basis. The proposed BART limits would result in an 86% reduction in current SO_2 emissions on a lb/mmBtu basis. However, because NDDAQ has proposed no absolute limits on emissions, unlimited operation at 0.24 lb/mmBtu could result in only a 77% reduction on a ton-per-year basis. If coal quality deteriorates to the anticipated worst-case (2.4 lb/mmBtu uncontrolled), the proposed BART limits would default to a 90% reduction on a lb/mmBtu basis and an 80% reduction in future SO_2 emissions on a ton/year basis.

While burning PRB sub-bituminous coal, NDDAQ is proposing 0.16 lb/mmBtu **<u>or</u>** 90% reduction on a 30-day rolling average basis. The proposed BART limits would result in a 91% reduction in current SO_2 emissions on a lb/mmBtu basis and an 85% reduction on a ton-per-year basis. If coal quality deteriorates to the anticipated worst-case (1.6 lb/mmBtu uncontrolled), the proposed BART limits would default to a 90% reduction on a lb/mmBtu basis and an 80% reduction in future SO_2 emissions on a ton/year basis.

Based upon NDDAQ's analysis, addition of the new SD/FF yields the cost-effectiveness values shown below, which we believe to be reasonable based upon BART determinations and proposals we have seen nationwide to date:

NDDAQ Estimates for SO_2 from burning	**lignite**	**PRB**
Annual Cost ($million)	$ 11.22	$ 11.22
Visibility Improvement at TRNP (dv)	0.77	0.51
Cost-Effectiveness ($million/dv)	$ 14.53	$ 21.92
Cumulative Visibility Improvement (dv)	1.51	1.00
Cost-Effectiveness ($million/dv)	$ 7.43	$ 11.20

We recommend limits of 0.09 lb/mmBtu **<u>and</u>** 93% reduction on a 30-day rolling average for both fuels based upon recent determination by other states for EGUs burning coals with similar uncontrolled emissions. Even if coal quality deteriorates to the anticipated worst-case 2.4 lb/mmBtu, 96% control would still meet the 0.0.09 lb/mmBtu limit. We also recommend short and long-term absolute (e.g., lb/hr, tpy) caps on emissions to insure that emissions will not increase greatly over time.

<u>B. Nitrogen Oxides</u>

Step 1: Identify All Available Technologies

We believe that NDDAQ should have included SOFA with tail-end SCR with reheat in its analysis.

[12] Our control-effectiveness factor is simply dv/ (tons per year reduced) and assumes a linear relationship for a given pollutant.

Step 2: Eliminate Technically Infeasible Options
Except as noted above, we agree with NDDAQ's selection of technically feasible options.

Step 3: Evaluate Control Effectiveness of Each Remaining Control Technology
NDDAQ's estimates of control effectiveness appear reasonable. For example, based on the 0.44 lb/mmBtu NO_X baseline emission rate, outlet emissions projected by NDDAQ for SCR at 0.044 lb/mmBtu represent 90% SCR control efficiency and a reduction of 1,929 tpy.

Step 4: Evaluate Impacts and Document Results
NDDAQ's estimates of costs for low-dust SCR with reheat are summarized below. In developing that estimate, NDDAQ relied upon GRE's estimates which included a total capital cost for SCR with reheat of $56.6 million or $301/kW. Because this exceeds the expected range of $50 - $267/kW presented in our Appendix B, we request that GRE/NDDAQ document and justify this estimate.

GRE/NDDAQ also estimate that $3.2 million of the $7.7 million annual cost is a result of installing and operating a natural gas-fired gas reheating system to bring the flue gas back up to a temperature suitable for efficient SCR operation.

The result of NDDAQ's assumptions is that SCR would cost $6,475 per ton when burning lignite, and $8,163 per ton when burning PRB coal, which it deemed to be excessively costly.

As recommended by the BART Guidelines, we applied the methods described in Section 4.2 of EPA's Control Cost Manual and estimated the costs, including GRE's reheat cost estimates, which we believe to be more representative, as summarized below:

Stanton #1 SCR on Lignite Cost Summary

	GRE/NDDAQ	NPS
Total Capital Cost:	$ 56,554,445	$ 18,986,724
Total Capital Cost $/kW):	$ 301	$ 101
O&M Cost:	$ 7,676,364	$ 4,311,537
Total Annual Cost:	$ 12,490,000	$ 6,103,749
Cost per Ton	$ 6,475	$ 3,288

Stanton #1 SCR on PRB Cost Summary

	GRE/NDDAQ	NPS
Total Capital Cost:	$ 56,554,445	$ 18,388,465
Total Capital Cost $/kW):	$ 301	$ 98
O&M Cost:	$ 7,676,364	$ 4,120,838
Total Annual Cost:	$ 12,490,000	$ 5,856,579
Cost per Ton	$ 8,163	$ 5,880

NDDAQ has estimated a total annual cost for its proposed LNB+OFA+SNCR at $3.0 million with cost-effectiveness of $3,052 per ton when burning lignite, and $3,778 per ton when burning PRB coal, which it deemed to be reasonable.

Step 5: Evaluate Visibility Results

Based upon data supplied by GRE and by NDDAQ, we have estimated that, when burning lignite, the proposed LNB+OFA+SNCR will result in an approximately 0.09 dv improvement in visibility at Theodore Roosevelt NP and 0.18 dv cumulatively when Lostwood WA is included. When burning PRB coal, the proposed LNB+OFA+SNCR will result in an approximately 0.07 dv improvement in visibility at Theodore Roosevelt NP and 0.14 dv cumulatively when Lostwood WA is included.

Contrary to the BART Guidelines, NDDAQ did not evaluate the visibility benefits of LNB+OFA+SCR However, our review of NDDAQ visibility modeling yields a NO_x control-effectiveness factor for basic LNB+OFA+SNCR of 0.0004 dv/ton at Theodore Roosevelt NP and 0.0008 dv/ton cumulatively when Lostwood WA is included. By applying the NO_x control-effectiveness factor to NDDAQ's estimated 1,929 tpy reduction from burning lignite with LNB+OFA+SCR with reheat, we have estimated that addition of LNB+OFA+SCR with reheat will result in an approximately 0.3 dv improvement in visibility at Theodore Roosevelt NP and 0.5 dv cumulatively when Lostwood WA is included. By applying the NO_x control-effectiveness factor to NDDAQ's estimated 1,530 tpy reduction from burning PRB coal with LNB+OFA+SCR with reheat, we have estimated that addition of LNB+OFA+SCR with reheat will result in an approximately 0.2 dv improvement in visibility at Theodore Roosevelt NP and 0.3 dv cumulatively when Lostwood WA is included.

Determine BART

NDDAQ is proposing addition of a LNB+OFA+SNCR to limit NO_x emissions when burning lignite to 0.29 lb/mmBtu, and 0.23 lb/mmBtu when burning PRB coal. Based upon NDDAQ's analysis, addition of the proposed LNB+OFA+SNCR yields a cost-effectiveness values shown below:

NDDAQ estimates for NOx from LNB+OFA+SNCR	lignite	PRB
Annual Cost ($million)	$ 3.00	$ 3.00
Visibility Improvement at TRNP (dv)	0.09	0.07
Cost-Effectiveness ($million/dv)	$ 33.09	$ 40.96
Cumulative Visibility Improvement (dv)	0.18	0.14
Cost-Effectiveness ($million/dv)	$ 16.92	$ 20.94

NDDAQ rejected tail-end SCR with reheat on the basis of excessive cost. NDDAQ's and NPS' analyses of addition of SCR with reheat yields the cost-effectiveness values shown below:

Estimates for NOx from	NDDAQ	NPS	NDDAQ	NPS
LNB+OFA+SCR burning	**lignite**	**lignite**	**PRB**	**PRB**
Annual Cost ($million)	$ 12.49	$ 6.10	$ 12.49	$ 5.86
Visibility Improvement at TRNP (dv)	0.30	0.29	0.24	0.16
Cost-Effectiveness ($million/dv)	$ 41.31	$ 20.98	$ 52.09	$ 37.52
Cumulative Visibility Improvement (dv)	0.55	0.52	0.43	0.28
Cost-Effectiveness ($million/dv)	$ 22.90	$ 11.63	$ 28.88	$ 20.80

Based upon BART determinations and proposals we have seen nationwide to date, our cumulative cost-effectiveness values appear to be reasonable

Conclusions & Recommendations

- We agree with NDDAQ that applying a wet scrubber at this site has so many adverse environmental consequences that we will not consider that option further.
- NDDAQ proposed adding a new SD/FF to limit SO_2 emissions while burning lignite to 0.24 lb/mmBtu **or** 90% reduction on a 30-day rolling average basis. We recommend limits of 0.09 lb/mmBtu **and** 93% reduction on a 30-day rolling average for both fuels. Even if coal quality deteriorates, 96% control would still meet the 0.09 lb/mmBtu limit. We also recommend short and long-term absolute (e.g., lb/hr, tpy) caps on emissions to insure that emission will not increase greatly over time.
- NDDAQ is proposing addition of a LNB+OFA+SNCR to limit NO_x emissions when burning lignite to 0.29 lb/mmBtu, and 0.23 lb/mmBtu when burning PRB coal. NDDAQ has estimated a total annual cost at $3.0 million with cost-effectiveness of $3,052 per ton when burning lignite, and $3,778 per ton when burning PRB coal.
- When burning lignite, the proposed LNB+OFA+SNCR will result in an approximately 0.09 dv improvement in visibility at Theodore Roosevelt NP and 0.18 dv cumulatively. When burning PRB coal, the proposed LNB+OFA+SNCR will result in an approximately 0.07 dv improvement in visibility at Theodore Roosevelt NP and 0.14 dv cumulatively.
- NDDAQ estimates that SCR would cost $6,475 per ton when burning lignite, and $8,163 per ton when burning PRB coal, which it deemed to be excessively costly. NDDAQ has overestimated the costs associated with SCR. Many of the costs presented by GRE and NDDAQ were much higher than we have seen presented at similar facilities and were not supported by GRE's documentation. More reliance should be placed upon use of the EPA Control Cost Manual when the source fails, as did GRE, to provide sufficient supporting documentation of its costs. Our application of the Control Cost Manual yielded much lower cost estimates for SCR.
- When burning lignite, addition of LNB+OFA+SCR will result in an approximately 0.3 dv improvement in visibility at Theodore Roosevelt NP and 0.5 dv cumulatively when Lostwood WA is included. Cost-effectiveness is $11.6 million/dv - $20.1 million/dv, on a cumulative basis.

- When burning PRB coal, addition of LNB+OFA+SCR with reheat will result in an approximately 0.2 dv improvement in visibility at Theodore Roosevelt NP and 0.3 dv cumulatively when Lostwood WA is included. Cost-effectiveness is \$20.1 - \$28.9 million/dv, on a cumulative basis.
- We believe that SCR may represent BART, especially when the modeling issues identified in other reviews are resolved.

Basin Electric Power Cooperative (BEPC) Leland Olds Station (LOS) Units #1 & #2

Basin Electric Power Cooperative (BEPC) operates Leland Olds Station (LOS) Units #1 & #2 in Stanton, ND. Both units are fired with ND lignite and PRB sub-bituminous coal. Out of 1,228 power plants in EPA's Clean Air Markets (CAM) database in 2008, the Leland Olds plant ranked #12 for sulfur dioxide (SO_2) at 47,948 tons and #90 for nitrogen oxides (NO_x) at 11,065 tons. According to modeling results provided by BEPC, emissions from Leland Olds cause 5.6 dv of impairment in visibility at Theodore Roosevelt NP and 10.9 dv cumulatively when Lostwood WA is included. Without additional emission controls, SO_2 emissions are expected to more than double by 2019 due to deteriorating lignite quality (higher sulfur, lower heating value).[13]

Leland Olds Unit #1

Unit #1 is wall-fired and is rated at 216 MW (gross) output; current emission control equipment consists of LNB and ESP. Of 3,558 units in EPA's Clean Air Markets (CAM) database in 2008, LOS #1 ranked #95 for SO_2 at 17,926 tons and #90 for NO_x at 2,855 tons. According to modeling results provided by BEPC, emissions from LOS #1 cause 2.2 dv of impairment in visibility at Theodore Roosevelt NP and 4.1 dv cumulatively when Lostwood WA is included.

A. Sulfur Dioxide

Step 1: Identify All Available Technologies
We agree that NDDAQ has chosen a reasonable suite of options.

Step 2: Eliminate Technically Infeasible Options
We agree with NDDAQ's selection of technically feasible options.

Step 3: Evaluate Control Effectiveness of Each Remaining Control Technology

[13] BEPC has determined that historic rates are not representative of future maximum 24-hour emissions and has requested NDDAQ to allow the use of an alternative baseline. NDDAQ agreed to the alternative baseline. The alternative baseline and post-control scenarios are based upon various control technology emission reductions being applied to emissions from burning future coal at a heat input equal to the 100% of the boiler design capacity rating.

We agree with NDDAQ's estimates of control effectiveness on current lignite. However, we believe that higher control efficiency is warranted for the future lower quality (3.90 lb/mmBtu) lignite.

Step 4: Evaluate Impacts and Document Results

The proposed cost ($496/kW) for adding the 95%-efficient wet scrubber appears reasonable. The result of NDDAQ's assumptions is that the new wet scrubber would cost $586 per ton, which it deemed reasonable.

NDDAQ estimates for FGD on LOS #1 Cost Summary

Total Capital Cost:	$ 107,220,000
Total Capital Cost $/kW):	$ 496
O&M Cost:	$ 8,350,000
Total Annual Cost:	$ 19,310,000
Cost per Ton	$ 586

Step 5: Evaluate Visibility Results

NDDAQ did not evaluate the impact of the new wet scrubber versus the baseline condition. Therefore, we based our analysis on NDDAQ's modeling report for addition of a new scrubber to LOS #2. From that data we calculated a SO_2 control-effectiveness factor for the new wet scrubbers of 0.00004 dv/ton at Theodore Roosevelt NP and 0.00007 dv/ton cumulatively when Lostwood WA is included.[14] We have estimated that the proposed new wet scrubber will result in an approximately 1.2 dv improvement in visibility at Theodore Roosevelt NP and 2.4 dv cumulatively when Lostwood WA is included.

Determine BART

NDDAQ is proposing addition of a new wet scrubber to limit SO_2 emissions to 0.15 lb/mmBtu **or** 95% reduction on a 30-day rolling average basis. According to NDDAQ:

> Sulfur content of the coal was the primary constituent of concern because SO_2 emissions are directly related to the amount of sulfur in the coal and are not as related to equipment design. A forty year mining plan was analyzed to determine the future maximum annual sulfur content to be used in the BART analysis. The results indicated that future delivered coal will have a maximum annual average sulfur content of approximately 1.13% with a standard deviation of 0.12%. A 30-day rolling average SO_2 emission rate was calculated using the maximum sulfur content plus 1 standard deviation (i.e., 1.25% S).

Because NDDAQ has proposed no absolute limits on emissions, the proposed BART limits would result in a 92% reduction in current SO_2 emissions on a lb/mmBtu basis and a 90% reduction on a ton-per-year basis. If coal quality deteriorates to the anticipated worst-case (3.90 lb/mmBtu[15] uncontrolled), the proposed BART limits would default to a 95% reduction in future SO_2 emissions.

[14] Our control-effectiveness factor is simply dv/ (tons per year reduced) and assumes a linear relationship for a given pollutant.

[15] assumes unit-specific 37.4S SO_2 emission factor

Based upon NDDAQ's analysis, we estimate that addition of the new wet scrubber yields a cost-effectiveness of $15.9 million at Theodore Roosevelt NP and $8.0 million per dv cumulatively when Lostwood WA is included.

NDDAQ Cost-Effectiveness for SO_2 from	LOS #1
Annual Cost ($million)	$ 19.31
Visibility Improvement at TRNP (dv)	1.22
Cost-Effectiveness ($million/dv)	$ 15.89
Cumulative Visibility Improvement (dv)	2.43
Cost-Effectiveness ($million/dv)	$ 7.96

We recommend 0.15 lb/mmBtu **and** 95% reduction on a 30-day rolling average basis because NDDAQ has determined that both of these levels are reasonable. Even if coal quality deteriorates to the anticipated worst-case, 96% control would still meet the 0.15 lb/mmBtu limit.[16] We also recommend short and long-term absolute (e.g., lb/hr, tpy) caps on emissions to insure that emissions will not increase greatly over time.

B. Nitrogen Oxides

Step 1: Identify All Available Technologies
We believe that NDDAQ should have included a combination of combustion controls (e.g., Low-NO_X Burners, Separated Over-Fire Air) coupled with SCR to its suite of options.

Step 2: Eliminate Technically Infeasible Options
Except as noted above, we agree with NDDAQ's selection of technically feasible options.

Step 3: Evaluate Control Effectiveness of Each Remaining Control Technology
Based on the 0.285 lb/mmBtu NO_X baseline emission rate, outlet emissions projected by NDDAQ for SCR at 0.07 lb/mmBtu represent only a 75% SCR control efficiency and a reduction of 2,225 tpy. (This is much lower than other analyses[17] in which NDDAQ has assumed 88% - 90% for SCR control effectiveness.)

We believe that a combination of combustion controls (e.g., SOFA) plus SCR can achieve 0.05 lb/mmBtu (83% NO_x removal from the 0.29 lb/mmBtu 2000 – 2008 CAM average) as opposed to the 75% estimated by NDDAQ for SCR alone. EPA's CAM data[18] (Appendix A) and vendor guarantees[19] show that SCR can typically meet 0.05

[16] For example, West Virginia issued a permit on 3/01/04 to Longview Power to burn coal with an uncontrolled emission rate of 4.04 lb/mmBtu and meet a 24-hour average limit of 0.12 lb/mmBtu, which is equivalent to 97% control.
[17] Leland Olds #2, MR Young #1 & #2, Stanton #1
[18] We found at least 17 examples (Please see Appendix A., Table A.1.) of wall-fired boilers similar to LOS #1 that have been retrofitted with SCR and are achieving annual emission rates below 0.06 lb/mmBtu. We were able to find 2006 hourly emissions in EPA's CAM database for 14 of those EGUs, and charts showing those emissions are included in the wall-fired boilers portion of Appendix A. We believe that inspection of the data leads to the conclusion that these SCRs retrofit to eastern EGUs burning bituminous coal can

lb/mmBtu (or lower) on an annual average basis. BEPC has not provided any documentation or justification to support the higher values used in its analyses. Our review of operating data (Appendix A) suggests that a NO_X limit of 0.06 lb/mmBtu is appropriate (with a safety-margin) for LNB/OFA+SCR for a 30-day rolling average, and 0.07 lb/mmBtu for a 24-hour limit and for modeling purposes, but a lower rate (e.g., 0.05 lb/mmBtu or lower) should be used for annual average and annual cost estimates.

Step 4: Evaluate Impacts and Document Results

NDDAQ has estimated a total annual cost for its proposed basic SOFA with SNCR at $3.0 million with cost-effectiveness of $2,487 per ton, which it deemed to be reasonable.

NDDAQ estimates for Basic SOFA + SNCR on LOS #1 Cost Summary

Total Capital Cost:	$ 6,234,000
Total Capital Cost $/kW):	$ 29
O&M Cost:	$ 2,030,000
Total Annual Cost:	$ 3,099,000
Cost per Ton	$ 2,487

According to BEPC:[20]

> The capital costs to implement the various NO_x control technologies were largely estimated from unit output capital cost factors ($/kW) published in technical papers discussing those control technologies. In the cases with SNCR, preliminary vendor budgetary cost information was obtained and used in place of, or to adjust, the published unit output cost factors. The capital costs for combinations of NOx reduction technologies evaluated were typically estimated based upon simple arithmetic addition of the individual unit output capital cost factors for these technologies, multiplied by the nameplate capacity ratings of the steam-electric generating units at Leland Olds Station. These cost estimates were adjusted for inflation where appropriate (to 2005$), and are considered to be study grade, which is + or – 30% accuracy, or better.

For its LOS #1 SCR with reheat cost estimates, NDDAQ simply scaled the costs estimated by BEPC for the ASOFA+tail-end SCR with reheat option at LOS #2 based on the electrical output.[21] (Please see our discussion of the LOS #2 NO_x control cost estimates.) As a result, the $377 - $388/kW capital cost estimates actually used by BEPC are much higher than suggested by available information (Please see Appendix B cost summaries.) which suggests SCR costs ranging from $50 - $267/kW. BEPC has provided no justification for these extraordinarily high costs. Furthermore, neither BEPC nor NDDAQ provide any basis for their operating cost estimates which are roughly double those we estimated by applying the methods recommended by EPA in its Control Cost Manual. (Please see Appendix B.) NDDAQ has estimated a total annual cost for low-dust

typically reduce NO_x emissions by 90% and achieve 0.05 lb/mmBtu (or lower) on a 30-day rolling average basis during the eastern ozone season.

[19] Minnesota Power has stated in its Taconite Harbor BART analysis that "The use of an SCR is expected to achieve a NO_X emission rate of 0.05 lb/mmBtu based on recent emission guarantees offered by SCR system suppliers."

[20] from Burns & McDonnel 8/2006 **A2.1 Capital Cost Estimates for NO_x Controls**

[21] However, it is likely that this approach overestimated costs because of the higher cost of ASOFA at LOS #2 relative to SOFA at LOS #1.

SCR with reheat at $21.5 – 31.0 million. The result of NDDAQ's assumptions is that SCR would cost $9,600 - 14,000 per ton, which it deemed to be excessively costly.

NDDAQ estimates for SCR w Reheat on LOS #1 Cost Summary		
Cost	low	high
Total Capital Cost:	$ 81,392,727	$ 83,847,273
Total Capital Cost $/kW):	$ 377	$ 388
Catalyst ($/m^3)	$ 7,500	$ 7,500
Catalyst Life (hours)	$ 8,000	$ 4,000
Electricity ($/MWh)	$ 50	$ 50
Ammonia ($/ton)	$ 750	$ 750
Natural Gas ($/mcf)	$ 8	$ 12
O&M Cost:	$ 12,091,091	$ 19,867,091
Total Annual Cost:	$ 21,517,000	$ 31,011,000
Cost per Ton	$ 9,669	$ 13,936

In the absence of supporting documentation by BEPC or NDDAQ, as recommended by the BART Guidelines, we applied the methods described in Section 4.2 of EPA's Control Cost Manual and estimated a capital cost range of $101 - $142/kW which is much more consistent with available information. (Please see Appendix B.) We also estimated a total annual cost for basic SOFA+SCR with reheat at $6.5 – $15.0 million and $3,275 – $7,563 per ton.[22]

NPS estimates for SCR w Reheat on LOS #1 Cost Summary			
Cost	low	mid	high
Total Capital Cost:	$ 21,792,974	$ 21,792,974	$ 30,606,301
Total Capital Cost $/kW):	$ 101	$ 101	$ 142
Catalyst ($/m^3)	$ 3,000	$ 3,000	$ 7,500
Catalyst Life (hours)	$ 24,000	$ 8,000	$ 4,000
Electricity ($/MWh)	$ 38	$ 38	$ 50
Ammonia ($/ton)	$ 304	$ 304	$ 750
Natural Gas ($/mcf)	$ 8	$ 10	$ 12
O&M Cost:	$ 4,440,089	$ 5,634,987	$ 12,132,706
Total Annual Cost:	$ 6,512,534	$ 7,707,432	$ 15,037,898
Cost per Ton	$ 3,275	$ 3,876	$ 7,563

[22] The low end of this range, which we believe to be more representative of likely costs, is based upon an estimated 1,988 tpy reduction (@ 0.05 lb/mmBtu) and these operating costs estimated by NPS:

- Catalyst = $3,000/cubic meter (estimated by PacifiCorp in its BART analyses for its Wyoming EGUs) replaced every 24,000 hours[22]
- Electricity = $38/MWh (estimated by BEPC in its 8/2006 BART report)
- Ammonia = $304.45/ton (estimated by BEPC in its 8/2006 BART report)
- Natural gas = 56,455 mcf/hr @ $8/mcf from EIA forecast to 2030

Step 5: Evaluate Visibility Results
Based upon data supplied by BEPC and by NDDAQ, we have estimated that the proposed basic SOFA+SNCR will result in an approximately 0.1 dv improvement in visibility at Theodore Roosevelt NP and 0.2 dv cumulatively when Lostwood WA is included.

Contrary to the BART Guidelines, NDDAQ did not evaluate the visibility benefits of any of the technically-feasible options except for the proposed basic SOFA+SNCR. However, our review of NDDAQ visibility modeling yields a NO_x control-effectiveness factor for basic SOFA+SNCR of 0.00010 dv/ton at Theodore Roosevelt NP and 0.00019 dv/ton cumulatively when Lostwood WA is included. By applying the NO_x control-effectiveness factor to NDDAQ's estimated 2,225 tpy reduction from basic SOFA+SCR with reheat, we have estimated that addition of basic SOFA+SCR with reheat will result in an approximately 0.2 dv improvement in visibility at Theodore Roosevelt NP and 0.4 dv cumulatively when Lostwood WA is included.

Determine BART
Presumptive BART for this large wall-fired EGU burning lignite is 0.29 lb/mmBtu. NDDAQ is proposing that BART is an emission limit of 0.19 lb/10^6 Btu on a 30-day rolling average basis. Because NDDAQ has proposed no absolute limits on emissions, the proposed BART limits would result in a 30% reduction in current NO_x emissions on a lb/mmBtu basis and a 13% reduction on a ton-per-year basis.

Based upon NDDAQ's analysis, addition of the proposed basic SOFA+SNCR yields a cost-effectiveness of $25.6 million per dv at Theodore Roosevelt NP and $13.2 million per dv cumulatively when Lostwood WA is included.

NDDAQ Cost-Effectiveness Estimates for Basic SOFA+SNCR	LOS #1
Annual Cost ($million)	$ 3.10
Visibility Improvement at TRNP (dv)	0.11
Cost-Effectiveness ($million/dv)	$ 27.26
Cumulative Visibility Improvement (dv)	0.23
Cost-Effectiveness ($million/dv)	$ 13.59

NDDAQ rejected tail-end SCR with reheat on the basis of excessive cost. NDDAQ's analysis of addition of SCR with reheat yields a cost-effectiveness of $99.6 – $143.5 million per dv at Theodore Roosevelt NP and $51.2 – $73.8 million per dv cumulatively when Lostwood WA is included.

Cost-Effectiveness for SCR with Reheat on LOS Unit #1	NDDAQ		NPS		
	low	high	low	mid	high
Annual Cost ($million)	$ 21.52	$ 31.01	$ 6.80	$ 7.71	$ 15.04
Visibility Improvement at TRNP (dv)	0.20	0.20	0.62	0.62	0.61
Cost-Effectiveness ($million/dv)	$ 106.01	$ 152.78	$ 7.68	$ 9.16	$ 19.78
Cumulative Visibility Improvement (dv)	0.41	0.41	1.08	1.08	1.08
Cost-Effectiveness ($million/dv)	$ 52.85	$ 76.17	$ 4.37	$ 5.20	$ 11.24

NPS' analysis of addition of basic SOFA+SCR with reheat yields a cost-effectiveness of $7.7 – $19.8 million per dv at Theodore Roosevelt NP and $4.4 – $11.2 million per dv cumulatively when Lostwood WA is included.[23] We would normally consider costs above $20 million/dv to be above the average that most states/sources are proposing, but believe that these results warrant further analysis, as we will discuss in more detail with respect to LOS #2.

<u>Conclusions & Recommendations for LOS #1</u>

- NDDAQ is proposing addition of a new wet scrubber to limit SO_2 emissions to 0.15 lb/mmBtu **<u>or</u>** 95% reduction on a 30-day rolling average basis. We have estimated that the proposed new wet scrubber will result in an approximately 1.2 dv improvement in visibility at Theodore Roosevelt NP and 2.4 dv cumulatively when Lostwood WA is included. We commend NDDAQ for the proposed new wet scrubbers, but recommend that the limits require **<u>both</u>** 95% control **<u>and</u>** 0.15 lb/mmBtu, as well as specific caps on emissions.
- Presumptive NO_x BART for LOS #1 is 0.29 lb/mmBtu. NDDAQ is proposing that BART is an emission limit of 0.19 lb/10^6 Btu on a 30-day rolling average basis; this would improve visibility by 0.12 dv at Theodore Roosevelt NP and 0.24 dv cumulatively when Lostwood WA is included.
- Based upon NDDAQ's analysis, addition of the proposed basic SOFA+SNCR to LOS #1 yields a cost-effectiveness of $25.6 million per dv at Theodore Roosevelt NP and $13.2 million per dv cumulatively when Lostwood WA is included. NDDAQ has not adequately considered the visibility benefits of the control strategies it evaluated. NPS' analysis of addition of basic SOFA+SCR with reheat yields a cost-effectiveness of $12.6 – $32.3 million per dv cumulatively. We would normally consider costs above $20 million/dv to be above the average that most states/source are proposing, but believe that these results warrant further analysis, as we will discuss in more detail with respect to LOS #2.
- NDDAQ underestimated the effectiveness of adding SCR to LOS #1. Outlet emissions projected by NDDAQ for SCR at 0.07 lb/mmBtu represent only a 75% SCR control efficiency We believe that a combination of combustion controls (e.g., SOFA) plus SCR can achieve 0.05 lb/mmBtu, and represents BART.

[23] Our estimates were based upon the average NO_x emission rate in the CAM database for 2000 – 2008 and thus are significantly lower than the baseline emission estimated used by NDDAQ. As a consequence, our emission reductions are less, on a tpy basis, and our cost-effectiveness is negatively affected.

- NDDAQ overestimated the costs associated with adding SCR to LOS #1.Our application of the EPA Control Cost Manual yielded much lower cost estimates for SCR. Many of the costs associated with SCR presented by BEPC and NDDAQ were much higher than we have seen presented at similar facilities and were not supported by BEPC's documentation. More reliance should be placed upon use of the EPA Control Cost Manual when the source fails, as BEPC did for LOS, to provide sufficient supporting documentation of its costs.

Leland Olds Unit #2

Unit #2 is a cyclone furnace and is rated at 440 MW (gross) output; current emission control equipment consists of an ESP. Of 3,558 units in EPA's CAM database in 2008, the LOS #2 ranked #34 for SO_2 at 30,022 tons and #49 for NO_x at 8,210 tons. According to modeling results provided by BEPC, emissions from LOS #2 cause 3.4 dv of impairment in visibility at Theodore Roosevelt NP and 6.8 dv cumulatively when Lostwood WA is included.

However, NPS model results predict that emissions from LOS #2 cause 7.9 dv of impairment in visibility at Theodore Roosevelt NP and 13.5 dv cumulatively when Lostwood WA is included.[24]

A. Sulfur Dioxide

Step 1: Identify All Available Technologies

We agree that NDDAQ has chosen a reasonable suite of options.

Step 2: Eliminate Technically Infeasible Options

We agree with NDDAQ's selection of technically feasible options.

Step 3: Evaluate Control Effectiveness of Each Remaining Control Technology

We agree with NDDAQ's estimates of control effectiveness on current lignite. However, we believe that higher control efficiency is warranted for the future lower quality (4.04 lb/mmBtu) lignite.

Step 4: Evaluate Impacts and Document Results

The proposed costs ($335/kW) for adding the scrubbers appear reasonable. However, NDDAQ did not include any estimates of cost-effectiveness because it contends that it chose the most efficient option. We used NDDAQ's data to estimate that the new scrubber would cost $463/ton.

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[24] Our analysis was based upon the design values presented by BEPC in Table 1.2-1 of its 8/06 BART report. BEPC has determined that historic rates are not representative of future maximum 24-hour emissions and has requested NDDAQ to allow the use of an alternative baseline. NDDAQ agreed to the alternative baseline. The alternative baseline and post-control scenarios are based upon various control technology emission reductions being applied to emissions from burning future coal at a heat input equal to the 100% of the boiler design capacity rating.

NDDAQ Estimates for FGD on LOS #2 Cost Summary

Total Capital Cost:	$ 147,600,000
Total Capital Cost $/kW):	$ 335
O&M Cost:	$ 14,210,000
Total Annual Cost:	$ 29,840,000
Cost per Ton	$ 463

Step 5: Evaluate Visibility Results

Based upon data supplied by BEPC and by NDDAQ, we have estimated that the proposed scrubber will result in an approximately 2.4 dv improvement in visibility at Theodore Roosevelt NP and 4.7 dv cumulatively when Lostwood WA is included. The NDDAQ visibility modeling yields a control-effectiveness factor for the new wet scrubber of 0.00004 dv/ton at Theodore Roosevelt NP and 0.00007 dv/ton cumulatively when Lostwood WA is included.

We re-modeled LOS #2 assuming that the new wet scrubber would reduce SO_2 emissions to 0.15 lb/mmBtu and held all other emissions to their baseline rates. Our results estimate that the scrubber would improve visibility by 5.6 dv at Theodore Roosevelt NP and 9.4 dv cumulatively when Lostwood WA is included. This yields a control-effectiveness factor for the new wet scrubber of 0.00009 dv/ton at Theodore Roosevelt NP and 0.00015 dv/ton cumulatively when Lostwood WA is included. We suggest that we investigate these major differences in modeling results further with NDDAQ.

Determine BART

NDDAQ is proposing to limit SO_2 emissions to 0.15 lb/mmBtu **<u>or</u>** a 95% reduction on a 30-day rolling average basis. As with Unit #1, sulfur content of the coal was the primary concern.

Because NDDAQ has proposed no absolute limits on emissions, the proposed BART limits would result in a 92% reduction in current SO_2 emissions on a lb/mmBtu basis and an 89% reduction on a ton-per-year basis. If coal quality deteriorates to the anticipated worst-case (4.04 lb/mmBtu[25] uncontrolled), the proposed BART limits would default to a 95% reduction in future SO_2 emissions.

Based upon NDDAQ's analysis, addition of the new wet scrubber yields a cost-effectiveness of $12.6 million, and $6.3 million per dv cumulatively when Lostwood WA is included.

[25] assumes unit-specific 38.7S SO_2 emission factor

NDDAQ Cost-Effectiveness for SO_2 from	LOS #2
Annual Cost ($million)	$ 29.84
Visibility Improvement at TRNP (dv)	2.38
Cost-Effectiveness ($million/dv)	$ 12.55
Cumulative Visibility Improvement (dv)	4.74
Cost-Effectiveness ($million/dv)	$ 6.29

We recommend 0.15 lb/mmBtu **and** 95% reduction on a 30-day rolling average basis because NDDAQ has determined that both of these levels are reasonable. Even if coal quality deteriorates to the anticipated worst-case, 96% control would still meet the 0.15 lb/mmBtu limit. We also recommend short and long-term absolute (e.g., lb/hr, tpy) caps on emissions to insure that emissions will not increase greatly over time.

B. Nitrogen Oxides

Step 1: Identify All Available Technologies
We agree that NDDAQ has chosen a reasonable suite of options.

Step 2: Eliminate Technically Infeasible Options
We agree with NDDAQ's selection of technically feasible options.

Step 3: Evaluate Control Effectiveness of Each Remaining Control Technology
Based on the 0.67 lb/mmBtu NO_X baseline emission rate, outlet emissions projected by NDDAQ for SCR at 0.07 lb/mmBtu represent a 90% SCR control efficiency and a reduction of 10,821 tpy. We suggest that, if ASOFSA can reduce emissions to 0.5 lb/mmBtu as estimated by NDDAQ, then addition of SCR at 90% as assumed by NDDAQ could bring emissions down to 0.05 lb/mmBtu.

Step 4: Evaluate Impacts and Document Results
NDDAQ has estimated a total annual cost for ASOFA with SNCR at $10.9 million with cost-effectiveness of $1,659 per ton, which it deemed to be reasonable.

NDDAQ Estimates for ASOFA + SNCR on LOS #2 Cost Summary

Total Capital Cost:	$ 16,800,000
Total Capital Cost $/kW):	$ 38
O&M Cost:	$ 7,830,000
Total Annual Cost:	$ 10,870,000
Cost per Ton	$ 1,659

BEPC submitted a separate analysis of ASOFA+tail-end SCR with reheat to NDDAQ in May 2009. (This became the basis for NDDAQ's scaling approach to its LOS #1 cost estimates.) BEPC based its capital cost estimates upon assumed ranges of costs for the control options evaluated. However, BEPC did not explain the origin of its cost ranges, and we believe that the ">$300/kW" estimate for ASOFA+tail-end SCR with reheat may be too high. In fact, the $377 - $388/kW capital cost estimates actually used by BEPC are much higher than suggested by available information (see Appendix B cost summaries) which suggests SCR costs ranging from $50 - $267/kW. BEPC has provided no justification for these extraordinarily high costs. Furthermore, neither BEPC nor NDDAQ provide any basis for their operating cost estimates which are roughly double those we estimated by applying the methods recommended in the Control Cost Manual. (Please see Appendix B.) NDDAQ has estimated a total annual cost for ASOFA+tail-end SCR with reheat at $43.8 – 63.2 million. The result is that ASOFA+tail-end SCR with reheat would cost over $4,000 - $5,800 per ton, which it deemed to be excessively costly.

NDDAQ Estimates for ASOFA + SCR with Reheat on LOS #2 Cost Summary		
	low	high
Total Capital Cost:	$ 165,800,000	$ 170,800,000
Total Capital Cost $/kW):	$ 377	$ 388
Catalyst ($/m^3)	$ 7,500	$ 7,500
Catalyst Life (hours)	8,000	4,000
Electricity ($/MWh)	$ 50.00	$ 50.00
Ammonia ($/ton)	$ 750.00	$ 750.00
Natural Gas ($/mcf)	$ 8.00	$ 12.00
O&M Cost:	$ 24,630,000	$ 40,470,000
Total Annual Cost:	$ 43,830,000	$ 63,170,000
Cost per Ton	$ 4,051	$ 5,838

In the absence of supporting documentation by BEPC or NDDAQ, as recommended by the BART Guidelines, we applied the methods described in the Control Cost Manual to the ASOFA+tail-end SCR with reheat option and estimated a capital cost range of $84 - $131/kW which is much more consistent with available literature which suggests SCR costs ranging from $50 - $267/kW. We applied the methods recommended by EPA and its Control Cost manual and estimated total annual costs for ASOFA+tail-end SCR with reheat at $13.8 – $28.7 million and $1,773 - $3,807 per ton.[26] (Please see Appendix B.)

[26] The low end of this range, which we believe to be more representative of likely costs, is based upon an estimated 7,530 tpy reduction (@ 0.06 lb/mmBtu)[26] and these operating costs estimated by NPS:

- Catalyst = $3,000/cubic meter (estimated by PacifiCorp in its BART analyses for its Wyoming EGUs) replaced every 24,000 hours
- Electricity = $38/MWh (estimated by BEPC in its 8/2006 BART report)
- Ammonia = $304.45/ton (estimated by BEPC in its 8/2006 BART report)
- Natural gas = 115,000 mcf/hr @ $8/mcf from EIA forecast to 2030

NPS Estimates for ASOFA + SCR with Reheat on LOS #2 Cost Summary			
	low	mid	high
Total Capital Cost:	$ 37,089,544	$ 37,089,544	$ 57,541,216
Total Capital Cost $/kW):	$ 84	$ 84	$ 131
Catalyst ($/m^3)	$ 3,000	$ 3,000	$ 7,500
Catalyst Life (hours)	24,000	8,000	4,000
Electricity ($/MWh)	$ 38.00	$ 38.00	$ 50.00
Ammonia ($/ton)	$ 304.45	$ 304.45	$ 750.00
Natural Gas ($/mcf)	$ 8.00	$ 10.00	$ 12.00
O&M Cost:	$ 8,918,956	$ 11,141,667	$ 22,307,414
Total Annual Cost:	$ 13,349,450	$ 15,572,161	$ 28,668,401
Cost per Ton	$ 1,773	$ 2,068	$ 3,807

Step 5: Evaluate Visibility Results

Based upon data supplied by BEPC and by NDDAQ, we have estimated that the proposed ASOFA + SNCR will result in an approximately 0.6 dv improvement in visibility at Theodore Roosevelt NP and 1.2 dv cumulatively when Lostwood WA is included. Our review of NDDAQ visibility modeling yields a NO_x control-effectiveness factor for the proposed combustion controls of 0.0004 dv/ton at Theodore Roosevelt NP and 0.0008 dv/ton cumulatively when Lostwood WA is included.

We re-modeled LOS #2 assuming that the proposed ASOFA + SNCR would reduce NO_X emissions to 0.35 lb/mmBtu. (We modeled SO_2 at 0.15 lb/mmBtu and held all other emissions to their baseline rates.) Our results estimate that ASOFA + SNCR would improve visibility by 1.1 dv at Theodore Roosevelt NP and 1.7 dv cumulatively when Lostwood WA is included.

Based upon data supplied by BEPC and by NDDAQ, we have estimated that addition of ASOFA+tail-end SCR with reheat will result in an approximately 1.1 dv improvement in visibility at Theodore Roosevelt NP and 2.0 dv cumulatively when Lostwood WA is included. Our review of NDDAQ visibility modeling for LOS #2 yields a NO_x control-effectiveness factor for the ASOFA+tail-end SCR with reheat option of 0.00010 dv/ton at Theodore Roosevelt NP and 0.00019 dv/ton cumulatively when Lostwood WA is included.

We re-modeled LOS #2 assuming that ASOFA + SCR would reduce NO_X emissions to 0.06 lb/mmBtu. (We modeled SO_2 at 0.15 lb/mmBtu and held all other emissions to their baseline rates.) Our results estimate that ASOFA + SCR would improve visibility by 2.3 dv at Theodore Roosevelt NP and 4.1 dv cumulatively when Lostwood WA is included. This yields a control-effectiveness factor for ASOFA + SNCR of 0.00031 dv/ton at Theodore Roosevelt NP and 0.00054 dv/ton cumulatively when Lostwood WA is included. Our higher control-effectiveness results show that we are estimating that removing a ton of NO_x has greater benefits than estimated by BEPC/NDDAQ.

Determine BART

Presumptive BART for this large cyclone furnace is based upon application of SCR to achieve 0.10 lb/mmBtu on a 30-day rolling average basis. According to the BART Guidelines, "The use of SCRs at cyclone units burning bituminous coal, sub-bituminous coal, and ***lignite*** [emphasis added] should enable these units to cost-effectively meet NO_x rates of 0.10 lb/mmBtu."

Instead of meeting the presumptive BART limit of 0.10 lb/mmBtu, NDDAQ is proposing application of SNCR and Advanced SOFA (ASOFA) to limit NO_x emissions to 0.35 lb/mmBtu on a 30-day rolling average basis. This equates to a cost-effectiveness of $17.1 million per dv at Theodore Roosevelt NP and $8.8 million per dv cumulatively when Lostwood WA is included.

NDDAQ Cost-Effectiveness for ASOFA+SNCR	LOS #2
Annual Cost ($million)	$ 10.87
Visibility Improvement at TRNP (dv)	0.64
Cost-Effectiveness ($million/dv)	$ 17.08
Cumulative Visibility Improvement (dv)	1.24
Cost-Effectiveness ($million/dv)	$ 8.78

Because NDDAQ has proposed no absolute limits on emissions, the proposed BART limits would result in a 43% reduction in current NO_x emissions on a lb/mmBtu basis and a 35% reduction on a ton-per-year basis.

NDDAQ rejected ASOFA+tail-end SCR with reheat on the basis of excessive cost. NDDAQ's analysis of addition of SCR with reheat yields a cost-effectiveness of $41.7 – $60.1 million per dv at Theodore Roosevelt NP and $21.4 – $30.9 million per dv cumulatively when Lostwood WA is included.

Cost-Effectiveness for SCR with Reheat on LOS #2	NDDAQ		NPS		
	low	high	low	mid	high
Annual Cost ($million)	$ 43.83	$ 63.17	$ 13.35	$ 15.57	$ 28.71
Visibility Improvement at TRNP (dv)	0.99	0.99	2.33	2.33	2.33
Cost-Effectiveness ($million/dv)	$ 44.41	$ 64.00	$ 3.83	$ 4.78	$ 9.59
Cumulative Visibility Improvement (dv)	1.98	1.98	4.10	4.10	4.10
Cost-Effectiveness ($million/dv)	$ 22.14	$ 31.91	$ 2.18	$ 2.72	$ 5.45

NPS' analysis of addition of basic ASOFA+SCR with reheat and using NDDAQ modeling results yields a cost-effectiveness of $3.8 – $9.6 million per dv at Theodore Roosevelt NP and $2.2 – $5.5 million per dv cumulatively when Lostwood WA is included.[27] We believe that our cost estimates indicate that addition of SCR with reheat is

[27] Our estimates were based upon the average NO_x emission rate in the CAM database for 2000 – 2008 and thus are significantly lower than the baseline emission estimated used by NDDAQ. As a consequence, our emission reductions are less, on a tpy basis, and our cost-effectiveness is negatively affected.

reasonable based upon BART determinations and proposals we have seen nationwide to date. We also believe that the great disparity between modeling results produced by BEPC/NDDAQ and NPS requires resolution.

Conclusions & Recommendations for LOS #2

- NDDAQ is proposing to limit SO_2 emissions to 0.15 lb/mmBtu **or** 95% reduction on a 30-day rolling average basis. We recommend 0.15 lb/mmBtu **and** 95% reduction on a 30-day rolling average basis.
- Based upon data supplied by NDDAQ, we have estimated that the proposed scrubber will result in an approximately 2.4 dv improvement in visibility at Theodore Roosevelt NP and 4.7 dv cumulatively when Lostwood WA is included.
- We re-modeled LOS #2 assuming that the new wet scrubber would reduce SO_2 emissions to 0.15 lb/mmBtu and held all other emissions to their baseline rates. Our results estimate that the scrubber would improve visibility by 5.6 dv at Theodore Roosevelt NP and 9.4 dv cumulatively when Lostwood WA is included.
- Instead of meeting the presumptive NO_x BART limit of 0.10 lb/mmBtu, NDDAQ is proposing application of SNCR and ASOFA to limit NO_x emissions to 0.35 lb/mmBtu on a 30-day rolling average basis.
- Based upon data supplied by BEPC and by NDDAQ, we have estimated that the proposed ASOFA + SNCR will result in an approximately 0.64 dv improvement in visibility at Theodore Roosevelt NP and 1.24 dv cumulatively when Lostwood WA is included.
- We agree with NDDAQ's estimates of control effectiveness, but suggest that, if ASOFSA can reduce emissions to 0.5 lb/mmBtu as estimated by NDDAQ, then addition of SCR at 90% as assumed by NDDAQ could bring emissions down to 0.05 lb/mmBtu.
- NDDAQ overestimated the costs associated with adding SCR to LOS #2.Our application of the EPA Control Cost Manual yielded much lower cost estimates for SCR. Many of the costs associated with SCR presented by BEPC and NDDAQ were much higher than we have seen presented at similar facilities and were not supported by BEPC's documentation. More reliance should be placed upon use of the EPA Control Cost Manual when the source fails, as BEPC did for LOS #2, to provide sufficient supporting documentation of its costs.
- We re-modeled LOS #2 and estimate that ASOFA + SCR would improve visibility by 2.3 dv at Theodore Roosevelt NP and 4.1 dv cumulatively when Lostwood WA is included. Our higher control-effectiveness results show that we are estimating that removing a ton of NO_x has greater benefits than estimated by BEPC/NDDAQ.
- NPS' analysis of addition of ASOFA+SCR with reheat and using NDDAQ modeling results yields a cost-effectiveness of \$4.0 – \$9.6 million per dv at Theodore Roosevelt NP and \$2.3 – \$5.5 million per dv cumulatively when Lostwood WA is included. We believe that our cost estimates indicate that addition of SCR with reheat is reasonable based upon BART determinations and proposals we have seen nationwide to date.
- The great disparity between modeling results produced by BEPC/NDDAQ and NPS requires resolution.

Minnkota Power Cooperative Milton R. Young Station Units #1 & #2

Minnkota Power Cooperative (Minnkota) operates Milton R. Young Station (MRYS) Units #1 and Square Butte Electric Cooperative (Square Butte) operates MRYS Unit #2 near Center, ND. MRYS is located within 300 km of two Class I areas, Lostwood National Wildlife Refuge Wilderness Area (WA) administered by the U.S. Fish & Wildlife Service and Theodore Roosevelt National Park (NP) administered by the National Park Service.

Both units are cyclone boilers fired with ND lignite. Of 1,228 power plants in EPA's Clean Air Markets (CAM) database in 2008, MRYS ranked #75 for sulfur dioxide (SO_2) at 28,910 tons and #41 for nitrogen oxides (NO_x) at 16,793 tons. According to modeling results provided by Minnkota, emissions from MRYS cause 5.8 dv of impairment in visibility at Theodore Roosevelt NP and 10.6 dv cumulatively when Lostwood WA is included.

On April 24, 2006, EPA, the U. S. Department of Justice, NDDAQ, and Minnkota reached a settlement (Consent Decree = CD) of a New Source Review enforcement action. A Best Available Control Technology (BACT) analysis was required to be submitted by Minnkota within the following six months. That BACT analysis was submitted along with the BART analysis and is the basis for the BART analysis. However, a revised BACT analysis is expected soon.

Minnkota claims that the MRYS facility is not a "750 MW power plant" and thus does not have to meet EPA's presumptive BART limits. This claim is based upon the nameplate capacities of the BART-eligible units at MRYS, but it avoids the issue that, by modifying those units, MRYS now substantially exceeds the nameplate capacities. If the presumptive BART limits were triggered only by nameplate capacity, a source such as MRYS would be able to increase its capacity without ever triggering presumptive BART. Because MRYS is capable of generating more than 750 MW, presumptive BART limits apply.

Milton R. Young Station Unit #1

MRYS Unit #1 is a lignite-fired cyclone boiler rated at 257 MW (gross) output; current emission control equipment consists of an ESP. Out of 3,558 units in EPA's CAM database in 2008, MRYS #1 ranked #82 for SO_2 at 19,608 tons and #50 for NO_x at 8,193 tons. According to modeling results provided by Minnkota, emissions from MRYS #1 cause 3.0 dv of impairment in visibility at Theodore Roosevelt NP and 5.3 dv cumulatively when Lostwood WA is included.

A. Sulfur Dioxide

Step 1: Identify All Available Technologies
We agree that NDDAQ has chosen a reasonable suite of options.

Step 2: Eliminate Technically Infeasible Options
We agree with NDDAQ's selection of technically feasible options.

Step 3: Evaluate Control Effectiveness of Each Remaining Control Technology
We agree with NDDAQ's estimates of control effectiveness.

Step 4: Evaluate Impacts and Document Results
The proposed cost ($435/kW) for adding the 95%-efficient wet scrubber appears reasonable. The result of NDDAQ's assumptions is that the new wet scrubber would cost $1,105 per ton, which it deemed reasonable.

NDDAQ estimates for FGD on MRYS #1 Cost Summary

Total Capital Cost:	$ 111,776,000
Total Capital Cost $/kW):	$ 435
O&M Cost:	$ 10,282,000
Total Annual Cost:	$ 22,584,000
Cost per Ton	$ 1,105

Step 5: Evaluate Visibility Results
Our analysis of Minnkota's modeling report determined that the proposed new wet scrubber will result in an approximately 1.8 dv improvement in visibility at Theodore Roosevelt NP and 3.2 dv cumulatively when Lostwood WA is included.

Determine BART
NDDAQ proposed adding a new wet scrubber that achieves 95% reduction on a 30-day rolling average basis.

Based upon NDDAQ's analysis, we estimate that addition of the new wet scrubber yields a cost-effectiveness of $12.3 million per dv at Theodore Roosevelt NP and $7.0 million per dv cumulatively when Lostwood WA is included.

NDDAQ Cost-Effectiveness for SO_2 from	**MRYS #1**
Annual Cost ($million)	$ 22.58
Visibility Improvement at TRNP (dv)	1.83
Cost-Effectiveness ($million/dv)	$ 12.33
Cumulative Visibility Improvement (dv)	3.19
Cost-Effectiveness ($million/dv)	$ 7.09

We recommend addition of short and long-term absolute (e.g., lb/hr, tpy) caps on emissions to insure that emissions will not increase greatly over time.

B. Nitrogen Oxides

Step 1: Identify All Available Technologies
We agree that NDDAQ has chosen a reasonable suite of options.

Step 2: Eliminate Technically Infeasible Options
We agree with NDDAQ's selection of technically feasible options.

Step 3: Evaluate Control Effectiveness of Each Remaining Control Technology
Based on the 0.849 lb/mmBtu NO_X baseline emission rate, outlet emissions projected by NDDAQ for SCR at 0.085 lb/mmBtu represent a 90% SCR control efficiency and a reduction of 8,129 tpy. We agree with NDDAQ's estimates of control effectiveness, but suggest that, if ASOFSA can reduce emissions to 0.513 lb/mmBtu as estimated by NDDAQ, then addition of SCR at 90% could bring emissions down to 0.05 lb/mmBtu.

Step 4: Evaluate Impacts and Document Results
NDDAQ has estimated a total annual cost for its proposed ASOFA with SNCR at $7.4 million with cost-effectiveness of $2,541 per ton, which it deemed to be reasonable.

NDDAQ Estimates for ASOFA + SNCR on MRYS #1

Total Capital Cost:	$ 8,113,000
Total Capital Cost $/kW):	$ 32
O&M Cost:	$ 5,417,000
Total Annual Cost:	$ 7,472,000
Cost per Ton	$ 2,541

For its MRYS #1 SCR cost estimates, NDDAQ scaled the costs estimated for the ASOFA+tail-end SCR with reheat option at Leland Olds Station (LOS) #2 based on the electrical output. (Please see our discussion of the LOS #2 NO_x cost estimates.) As a result, the $377 - $388/kW capital cost estimates used by NDDAQ are much higher than suggested by available information (Please see Appendix B.) which suggests SCR costs ranging from $50 - $267/kW. NDDAQ has provided no justification for these extraordinarily high costs. Furthermore, NDDAQ did not provide any basis for their operating cost estimates which are roughly double those we estimated by applying the methods recommended the Control Cost Manual. NDDAQ has estimated a total annual cost for SCR with reheat at $25.6 – 36.9 million. The result of NDDAQ's assumptions is that SCR would cost $3,100 – 4,600 per ton, which it deemed to be reasonable.

SCR on MRYS #1 Cost Summary	NDDAQ		NPS
	low	high	
Total Capital Cost:	$ -	$ -	$ 17,762,559
Total Capital Cost $/kW):	$ -	$ -	$ 69
Catalyst ($/m^3)	$ 7,500	$ 7,500	$ 3,000
Catalyst Life (hours)	$ 8,000	$ 4,000	$ 24,000
Electricity ($/MWh)	$ 50	$ 50	$ 38
Ammonia ($/ton)	$ 750	$ 750	$ 304
Natural Gas ($/mcf)	$ 8	$ 12	$ 8
O&M Cost:	$ -	$ -	$ 5,578,686
Total Annual Cost:	$ 25,600,000	$ 36,897,000	$ 9,744,345
Cost per Ton	$ 3,149	$ 4,539	$ 1,028

In the absence of supporting documentation by NDDAQ, as recommended by the BART Guidelines, we applied the methods described in the Control Cost Manual and estimated a capital cost of \$69/kW which is much more consistent with available information. (Please see Appendix B.) We also estimated a total annual cost for ASOFA+SCR with reheat at \$9.7 million and \$1,028 per ton.

Step 5: Evaluate Visibility Results
Based upon data supplied by Minnkota and by NDDAQ, we have estimated that the proposed ASOFA+SNCR will result in an approximately 0.12 dv improvement in visibility at Theodore Roosevelt NP and 0.24 dv cumulatively when Lostwood WA is included.

Contrary to the BART Guidelines, NDDAQ did not evaluate the visibility benefits of any of the technically-feasible options except for the proposed ASOFA+SNCR. However, our review of NDDAQ visibility modeling yields a NO_x control-effectiveness factor for ASOFA+SNCR of 0.00020 dv/ton at Theodore Roosevelt NP and 0.00032 dv/ton cumulatively when Lostwood WA is included. By applying the NO_x control-effectiveness factor to NDDAQ's estimated 8,129 tpy reduction from ASOFA+SCR with reheat, we have estimated that addition of ASOFA+SCR with reheat will result in an approximately 1.7 dv improvement in visibility at Theodore Roosevelt NP and 2.6 dv cumulatively when Lostwood WA is included.

Determine BART
Presumptive BART for this cyclone-fired EGU burning lignite is 0.10 lb/mmBtu. NDDAQ is proposing that BART is an emission limit of 0.36 lb/mmBtu on a 30-day rolling average basis. Because NDDAQ has proposed no absolute limits on emissions, the proposed BART limits would result in a 42% reduction on a ton-per-year basis.

NDDAQ proposes that NO_X emissions be limited to 2,070.2 lb/hr on a 24-hour rolling average basis during startup. According to NDDAQ, the State of Montana in the permit for the Highwood Generating Station, EPA Region 9 in the permit for the Desert Rock Energy Center and the State of Nebraska in the Ag Soy Processing plant permit also included alternative limits for NO_x during startup and shutdown. The normal BART limit of 0.36 lb/10mmBtu will apply during all other periods including malfunctions. This is more than double the 1,152 lb/hr that would be allowed under normal operation.

However, the final (remanded) version of the Desert Rock permit states:

> Emissions from the PC boilers during startup and shutdown events shall not be subject to the emission limits in this permit which are specified in units of lb/MMBtu but shall be subject to all other limits and shall be included in the calculations of emission rates for demonstrating compliance with those limits.

We note that the approach taken by EPA regarding Desert Rock is similar to that taken by other states and limits the mass emission rate (e.g., lb/hr) to the rate under normal operation. We recommend that NDDAQ adopt this approach.

Based upon NDDAQ's analysis, addition of the proposed ASOFA+SNCR yields a cost-effectiveness of $25.6 million per dv at Theodore Roosevelt NP and $13.2 million per dv cumulatively when Lostwood WA is included.

NDDAQ Cost-Effectiveness Estimates for ASOFA+SNCR	MRYS #1
Annual Cost ($million)	$ 8.11
Visibility Improvement at TRNP (dv)	0.12
Cost-Effectiveness ($million/dv)	$ 25.61
Cumulative Visibility Improvement (dv)	0.24
Cost-Effectiveness ($million/dv)	$ 13.17

NDDAQ rejected tail-end SCR with reheat on the basis of excessive cost. NDDAQ's analysis of addition of SCR with reheat yields a cost-effectiveness of $15.4 – $22.2 million per dv at Theodore Roosevelt NP and $9.8 – $14.4 million per dv cumulatively when Lostwood WA is included.

Cost-Effectiveness for SCR with Reheat on MRYS Unit #1	NDDAQ		NPS
	low	high	
Annual Cost ($million)	$ 25.60	$ 36.90	$ 9.74
Visibility Improvement at TRNP (dv)	1.66	1.66	1.94
Cost-Effectiveness ($million/dv)	$ 15.42	$ 22.22	$ 5.03
Cumulative Visibility Improvement (dv)	2.61	2.61	3.04
Cost-Effectiveness ($million/dv)	$ 9.81	$ 14.14	$ 3.20

NPS' analysis of addition of ASOFA+SCR with reheat yields a cost-effectiveness of $5.0 million per dv at Theodore Roosevelt NP and $3.2 million per dv cumulatively when Lostwood WA is included. We believe that our cost estimates indicate that addition of SCR with reheat is reasonable based upon BART determinations and proposals we have seen nationwide to date.

Conclusions & Recommendations for MRYS #1

- NDDAQ proposed adding a new wet scrubber that achieves 95% reduction on a 30-day rolling average basis.
- We have estimated that the proposed new wet scrubber will result in an approximately 1.8 dv improvement in visibility at Theodore Roosevelt NP and 3.2 dv cumulatively when Lostwood WA is included. We commend NDDAQ for the proposed new wet scrubbers, but recommend that the limits require **both** 95% control **and** 0.15 lb/mmBtu, as well as specific caps on emissions.
- Presumptive NO_x BART for MRYS #1 is 0.10 lb/mmBtu. NDDAQ is proposing that BART is an emission limit of 0.36 lb/10^6 Btu on a 30-day rolling average basis to be met by addition of ASOFA+SNCR; this would improve visibility by 1.1 dv at Theodore Roosevelt NP and 1.7 dv cumulatively when Lostwood WA is included.

- NDDAQ proposes that NO_X emissions be limited to 2,070.2 lb/hr on a 24-hour rolling average basis during startup. We recommend that NDDAQ limit the mass emission rate (e.g., lb/hr) to the rate under normal operation.
- NDDAQ underestimated the effectiveness of adding ASOFA+SCR to MRYS #1. We suggest that ASOFSA+SCR can achieve 0.05 lb/mmBtu.
- NDDAQ overestimated the costs associated with adding SCR. In the absence of supporting documentation by NDDAQ, we also estimated a total annual cost for ASOFA+SCR with reheat at $9.7 million and $1,028 per ton.
- NPS' analysis of addition of ASOFA+SCR with reheat yields a cost-effectiveness of $5.0 million per dv at Theodore Roosevelt NP and $3.2 million per dv cumulatively when Lostwood WA is included.
- We believe that ASOFA+SCR with reheat represents BART for MRYS #1.

<u>**Milton R. Young Station Unit #2**</u>

MRYS Unit #2 is a lignite-fired cyclone boiler rated at 477 MW (gross) output; current emission control equipment consists of an ESP and a wet Flue Gas Desulfurization (FGD) system which treats 78% of the flue gas, while the remainder bypasses the scrubber and is used to reheat the stack gases. Overall sulfur dioxide (SO_2) control for Unit #2 is estimated to be about 75%. Out of 3,558 units in EPA's Clean Air Markets (CAM) database in 2008, MRYS #2 ranked #257 for SO_2 at 9,302 tons and #43 for NO_x at 8,599 tons. According to modeling results provided by Minnkota, emissions from MRYS #2 cause 2.8 dv of impairment in visibility at Theodore Roosevelt NP and 5.2 dv cumulatively when Lostwood WA is included.

<u>**A. Sulfur Dioxide**</u>

Step 1: Identify All Available Technologies
We agree that NDDAQ has chosen a reasonable suite of options.

Step 2: Eliminate Technically Infeasible Options
We agree with NDDAQ's selection of technically feasible options.

Step 3: Evaluate Control Effectiveness of Each Remaining Control Technology
We agree with NDDAQ's estimates of control effectiveness on current lignite. However, we believe that higher control efficiency is warranted for the future lower quality (3.48 lb/mmBtu) lignite.

Step 4: Evaluate Impacts and Document Results
The proposed costs ($52/kW) for upgrading the scrubber appears reasonable. NDDAQ data estimate that the scrubber upgrade would cost $565/ton.

NDDAQ Estimates for MRYS FGD Upgrade on #2 Cost Summary

Total Capital Cost:	$ 24,989,000
Total Capital Cost $/kW):	$ 52
O&M Cost:	$ 4,993,000
Total Annual Cost:	$ 8,414,000
Cost per Ton	$ 565

Step 5: Evaluate Visibility Results

Based upon data supplied by Minnkota and by NDDAQ, we have estimated that the proposed scrubber upgrade will result in an approximately 1.2 dv improvement in visibility at Theodore Roosevelt NP and 2.2 dv cumulatively when Lostwood WA is included. The NDDAQ visibility modeling yields a control-effectiveness factor for the new wet scrubber of 0.00008 dv/ton at Theodore Roosevelt NP and 0.00015 dv/ton cumulatively when Lostwood WA is included.

Determine BART

NDDAQ proposes that BART is 95% reduction **or** 0.15 lb/10^6 Btu on a 30-day rolling average basis. However, the Consent Decree requires a minimum of 90% reduction. This requirement will also be incorporated into the BART limit.

Because NDDAQ has proposed no absolute limits on emissions, the proposed BART limits would result in a 78% reduction in current SO_2 emissions on a lb/mmBtu basis and a 67% reduction on a ton-per-year basis. If coal quality deteriorates to the anticipated worst-case (3.48 lb/mmBtu uncontrolled), the proposed BART limits would default to a 96% reduction in future SO_2 emissions.

Based upon NDDAQ's analysis, addition of the new wet scrubber yields a cost-effectiveness of $7.1 million at Theodore Roosevelt NP and $3.8 million per dv cumulatively when Lostwood WA is included.

NDDAQ Cost-Effectiveness for SO_2 from	MRYS #2
Annual Cost ($million)	$ 8.41
Visibility Improvement at TRNP (dv)	1.19
Cost-Effectiveness ($million/dv)	$ 7.10
Cumulative Visibility Improvement (dv)	2.20
Cost-Effectiveness ($million/dv)	$ 3.82

We recommend 0.15 lb/mmBtu **and** 95% reduction on a 30-day rolling average basis because NDDAQ has determined that both of these levels are reasonable. Even if coal quality deteriorates to the anticipated worst-case, 96% control would still meet the 0.15 lb/mmBtu limit. We also recommend short and long-term absolute (e.g., lb/hr, tpy) caps on emissions to insure that emissions will not increase greatly over time.

B. Nitrogen Oxides

Step 1: Identify All Available Technologies
We agree that NDDAQ has chosen a reasonable suite of options.

Step 2: Eliminate Technically Infeasible Options
We agree with NDDAQ's selection of technically feasible options.

Step 3: Evaluate Control Effectiveness of Each Remaining Control Technology
We agree with NDDAQ's estimates of control effectiveness, but suggest that, if ASOFSA can reduce emissions to 0.489 lb/mmBtu as estimated by NDDAQ, then addition of SCR at 90% could bring emissions down to 0.05 lb/mmBtu.

Step 4: Evaluate Impacts and Document Results
NDDAQ has estimated a total annual cost for ASOFA with SNCR at $11.4 million with cost-effectiveness of $1,268 per ton, which it deemed to be reasonable.

For its MRYS #2 SCR with reheat cost estimates, NDDAQ simply scaled the costs estimated for the ASOFA+tail-end SCR with reheat option at LOS #2 based on the electrical output. (Please see our discussion of the LOS #2 NO_x control cost estimates.) As a result, the $377 - $388/kW capital cost estimates actually used by NDDAQ are much higher than suggested by available information (Please see Appendix B cost summaries.). NDDAQ has provided no justification for these extraordinarily high costs. Furthermore, NDDAQ did not provide any basis for their operating cost estimates which are roughly double those we estimated by applying the methods recommended by EPA in its Control Cost Manual. (Please see Appendix B.) NDDAQ has estimated a total annual cost for low-dust SCR with reheat at $47.5 – 68.5 million. The result of NDDAQ's assumptions is that SCR would cost $3,400 – 4,900 per ton, which it deemed to be reasonable.

SCR on MRYS #2 Cost Summary	NDDAQ low	NDDAQ high	NPS
Total Capital Cost:	$ -	$ -	$ 28,345,453
Total Capital Cost $/kW):	$ -	$ -	$ 59
Catalyst ($/m^3)	$ 7,500	$ 7,500	$ 3,000
Catalyst Life (hours)	$ 8,000	$ 4,000	$ 24,000
Electricity ($/MWh)	$ 50	$ 50	$ 38
Ammonia ($/ton)	$ 750	$ 750	$ 304
Natural Gas ($/mcf)	$ 8	$ 12	$ 8
O&M Cost:	$ -	$ -	$ 10,434,981
Total Annual Cost:	$ 47,516,000	$ 68,482,000	$ 15,599,591
Cost per Ton	$ 3,405	$ 4,907	$ 898

In the absence of supporting documentation by Minnkota or NDDAQ, as recommended by the BART Guidelines, we applied the methods described in EPA's OAQPS Control Cost Manual to the ASOFA+tail-end SCR with reheat option and estimated a capital cost range of $59 /kW which is much more consistent with available literature which suggests

SCR costs ranging from \$50 - \$267/kW. We also estimated total annual costs for ASOFA+tail-end SCR with reheat at \$15.6 million and \$898 per ton. (Please see Appendix B.)

Step 5: Evaluate Visibility Results

Based upon data supplied by Minnkota and by NDDAQ, we have estimated that the proposed ASOFA + SNCR will result in an approximately 0.7 dv improvement in visibility at Theodore Roosevelt NP and 1.4 dv cumulatively when Lostwood WA is included. Our review of NDDAQ visibility modeling yields a NO_x control-effectiveness factor for the proposed combustion controls of 0.00008 dv/ton at Theodore Roosevelt NP and 0.00015 dv/ton cumulatively when Lostwood WA is included.

Based upon data supplied by Minnkota and by NDDAQ, we have estimated that addition of ASOFA+tail-end SCR with reheat will result in an approximately 1.1 dv improvement in visibility at Theodore Roosevelt NP and 2.0 dv cumulatively when Lostwood WA is included. Our review of NDDAQ visibility modeling for MRYS #1 yields a NO_x control-effectiveness factor for the ASOFA+tail-end SCR with reheat option of 0.00010 dv/ton at Theodore Roosevelt NP and 0.00019 dv/ton cumulatively when Lostwood WA is included.

Determine BART

Presumptive BART for this large cyclone furnace is based upon application of SCR to achieve 0.10 lb/mmBtu on a 30-day rolling average basis. According to the BART Guidelines, "The use of SCRs at cyclone units burning bituminous coal, sub-bituminous coal, and ***lignite*** [emphasis added] should enable these units to cost-effectively meet NO_x rates of 0.10 lb/mmBtu."

Instead of meeting the presumptive BART limit of 0.10 lb/mmBtu, NDDAQ is proposing application of SNCR and Advanced SOFA to limit NO_x emissions to 0.35 lb/mmBtu on a 30-day rolling average basis. This equates to a cost-effectiveness of \$16.1 million per dv at Theodore Roosevelt NP and \$8.4 million per dv cumulatively when Lostwood WA is included.

NDDAQ Cost-Effectiveness for SOFA+SNCR	MRYS #2
Annual Cost (\$million)	\$ 11.41
Visibility Improvement at TRNP (dv)	0.70
Cost-Effectiveness (\$million/dv)	\$ 16.18
Cumulative Visibility Improvement (dv)	1.37
Cost-Effectiveness (\$million/dv)	\$ 8.35

Because NDDAQ has proposed no absolute limits on emissions, the proposed BART limits would result in a 57% reduction in current NO_x emissions on a lb/mmBtu basis and a 34% reduction on a ton-per-year basis.

NDDAQ proposes that NO_X emissions be limited to 3995.6 lb/hr on a 24-hour rolling average basis during startup, for the reasons discussed with respect to MRYS #1. This is almost double the 2,205 lb/hr that would be allowed under normal operation. We again note that the approach taken by EPA regarding Desert Rock is similar to that taken by other states and limits the mass emission rate (e.g., lb/hr) to the rate under normal operation. We recommend that NDDAQ adopt this approach.

NDDAQ rejected ASOFA+tail-end SCR with reheat on the basis of excessive cost. NDDAQ's analysis of addition of SCR with reheat yields a cost-effectiveness of \$43.4 – \$62.6 million per dv at Theodore Roosevelt NP and \$22.4 – \$32.3 million per dv cumulatively when Lostwood WA is included.

Cost-Effectiveness for SCR w Reheat on MRYS #2	**NDDAQ**		**NPS**
	low	**high**	**low**
Annual Cost ($million)	$ 47.52	$ 68.48	$ 15.60
Visibility Improvement at TRNP (dv)	1.09	1.09	1.36
Cost-Effectiveness ($million/dv)	$ 43.45	$ 62.63	$ 11.46
Cumulative Visibility Improvement (dv)	2.12	2.12	2.64
Cost-Effectiveness ($million/dv)	$ 22.42	$ 32.32	$ 5.91

NPS' analysis of addition of basic ASOFA+SCR with reheat and using NDDAQ modeling results yields a cost-effectiveness of \$11.5 million per dv at Theodore Roosevelt NP and \$5.9 million per dv cumulatively when Lostwood WA is included. We believe that our cost estimates indicate that addition of SCR with reheat is reasonable based upon BART determinations and proposals we have seen nationwide to date.

Conclusions & Recommendations for MRYS #2

- NDDAQ is proposing upgrading the existing wet scrubber to limit SO_2 emissions to 0.15 lb/mmBtu **or** 95% reduction on a 30-day rolling average basis. We have estimated that the proposed scrubber upgrade will result in an approximately 1.2 dv improvement in visibility at Theodore Roosevelt NP and 2.2 dv cumulatively when Lostwood WA is included. We commend NDDAQ for the proposed new wet scrubbers, but recommend that the limits require **both** 95% control **and** 0.15 lb/mmBtu, as well as specific caps on emissions.
- Presumptive NO_x BART for MRYS #2 is 0.10 lb/mmBtu. NDDAQ is proposing that BART is an emission limit of 0.35 lb/mmBtu on a 30-day rolling average basis to be met by addition of ASOFA+SNCR; this would improve visibility by 0.7 dv at Theodore Roosevelt NP and 1.4 dv cumulatively when Lostwood WA is included.
- NDDAQ proposes that NO_X emissions be limited to 3,995.6 lb/hr on a 24-hour rolling average basis during startup. We recommend that NDDAQ limit the mass emission rate (e.g., lb/hr) to the rate under normal operation.
- NDDAQ underestimated the effectiveness of adding ASOFA+SCR to MRYS #2. We suggest that ASOFSA+SCR can achieve 0.05 lb/mmBtu.
- NDDAQ overestimated the costs associated with adding SCR. In the absence of supporting documentation by NDDAQ, we estimated total annual costs for ASOFA+tail-end SCR with reheat at \$15.6 million and \$898 per ton.

- NPS' analysis of addition of basic ASOFA+SCR with reheat and using NDDAQ modeling results yields a cost-effectiveness of $11.5 million per dv at Theodore Roosevelt NP and $5.9 million per dv cumulatively when Lostwood WA is included.
- We believe that ASOFA+SCR with reheat represents BART for MRYS #2.

Section Eight: Visibility Modeling

As noted in Section 8.1, NDDAQ used a unique hybrid modeling approach to air quality modeling to project the 2018 reasonable progress goals. This approach involved nesting the local CALPUFF domain within the WRAP CMAQ domain, and applying the Lagrangian CALPUFF model in a retrospective sense to more realistically define plume geometry for local point sources.

We appreciate the effort by NDDAQ to address some of the limitations of the larger (36 km) grid and limited near-field impacts of the WRAP regional modeling. However, we are concerned that the modeling system developed by NDDAQ has shortcomings that limit its usefulness as an alternative modeling approach.

NDDAQ indicates that the purpose of the hybrid modeling is as weight of evidence to discount the impact of international (particularly Canadian) emissions and to better represent plume dispersion from point sources, particularly those closer to the Class I areas. While the CMAQ 36 km grid resolution does allow dilution of the plumes from point sources, ND's hybrid modeling assumptions raise more questions that are answered. CALPUFF does allow tracking of individual plumes but the model chemistry is much simplified compared to CMAQ and the methods required to normalize CMAQ results to CMAQ-CALPUFF hybrid results becomes quite elaborate and questionable.

We raise the following technical issues with the CALPUFF application:

- Ammonia is known to be an important input to determine the amount of ammonium nitrate (NH_4NO_3) formed in CALPUFF. Regional ambient concentrations of ammonia are poorly understood. ND has one ammonia monitor at Beuluh; please describe the type of monitor and the land use at Beuluh compared to other areas of the CALPUFF domain. We question if this monitor is representative of the CALPUFF domain. We note that monthly average NH3 from 2001-2002 was used as background ammonia in CALPUFF after removing days influenced by a source region. The draft Plan should identify that source region.

- EPA disapproved the use of the Ammonia Limiting Method to define NH3 levels in the VISTAS application cited by NDDAQ.

- For POSTUTIL, hourly ammonia data for 2001 -2003 were used and the Plan does not mention removing data. The Plan should identify if different years were used for the two applications. It appears that the ammonia levels at Lostwood were doubled compared to measured values based on the expectation that Lostwood is closer to ammonia sources in Canada. However, that adds a subjective adjustment to the CALPUFF modeling that brings into question the presumption that CALPUFF modeling is more accurate than just using CMAQ at 36 km.

- We note that four ozone monitors in central ND were selected to represent background ozone in CALPUFF. Are there only four ozone monitors in the CALPUFF domain? Table 8.6 says background value for ozone was 30 ppb, but does not link this to monitoring data.

We question the Hybrid model performance evaluation. Model performance evaluations are usually based on raw model output. We understand that the Hybrid model results were normalized before evaluation and then were normalized again to the WRAP baseline results. The need to normalize the CALPUFF relative response factors to the WRAP results, brings into question the value of using the CALPUFF hybrid regional model to discern the benefits of NDDAQ strategies.

In summation, we are not certain that the results from the Hybrid modeling have a substantial impact on the overall result. The conclusions under either the WRAP modeling or the Hybrid model are the same; the two Class I areas in North Dakota do not meet the uniform rate of progress guidance for this first planning period.

Section 8.6, including Figure 8.10, describes a possible way to account for international emissions when assessing the progress toward the goal of natural conditions. While we agree that examining the contribution to extinction for each aerosol species is a good approach to understanding if a State is meeting its fair share of emissions reductions associated with visibility impacts at a Class I area, the method described in this section and in the figure raise concerns since there was no assessment of the international component of the natural condition estimate. The value in 2064 illustrated in Figure 8.10 uses the same natural condition endpoint for the total extinction as well as the "U.S. Source" extinction, yet the 2064 natural condition estimates for aerosol species include some global or international component. We believe that a better way to address reasonable progress by extinction component is to assess the reduction needed for each aerosol species measured in the baseline period to the end of the first planning period and then assess if a state's plan achieves a comparable reduction for its share of extinction at the Class I areas.

Section Nine: Reasonable Progress Goals

The State should rely on WRAP regional modeling as the primary tool for demonstrating progress toward visibility improvement goals. The CMAQ-CALPUFF hybrid modeling is problematic in several ways and gains ND little benefits compared to using WRAP products. Two WRAP products that were omitted but should be included to help ND in making its reasonable progress determination are 1) Weighted Emissions Potential (WEP) and 2) extinction glide paths for SO_4, NO_3, and OC.

The uniform rate of progress glide path cannot be revised to account for contributions from natural sources or international sources under current or 2018 conditions without also removing these contributions from the 2064 endpoint. While the contribution from natural and international sources by 2064 is unknown, it may be comparable to current contributions. Therefore removing the estimated contributions from current conditions without also accounting for those contributions to the 2064 endpoint inappropriately changes the slope of the uniform rate of progress

It would be more appropriate to use the WRAP CAMx-PSAT results to demonstrate the relative contributions to sulfate and nitrate from Canadian and ND emissions at the North Dakota Class I areas. The Plan has already included these results in Table 6.7.

We suggest NDDAQ use the WRAP extinction glide paths to show the improvement in SO_4 or NO_3 due to emissions reductions from all sources in the WRAP 2018 inventory, and compare the ND emissions reductions by 2018 to emissions reductions from Canada and neighboring states. It would be informative for the Plan to include what percent of the State's total SO_2 and NO_X emissions from point sources is being reduced under BART. What other point source or area source reductions are reasonable?

For stationary sources, NDDAQ developed a methodology to look at options for controls for sources, beyond the source subject to BART, contributing to the major components of aerosol extinction on the worst 20 percent days. While we generally agree with the use of emissions over distance (Q/d) as a screening tool, we note that the Heskett facility was not included in Table 9.4 even though NDDAQ proposes to exclude the source from BART requirements.

Based on Q/d and some source process information, NDDAQ narrowed the focus of any additional control measures under the reasonable progress measures to the Basin Electric Antelope Valley Station (AVS) facility, the Otter Tail Power Coyote Station, the Dakota Gasification Great Plains Synfuels Plant, and the Hess Corporation Tioga Gas Plant.

Table 9.9 summarizes the results of assessing the costs and visibility improvement associated with possible controls on these facilities. The two power generation facilities, Coyote and AVS, have emissions and Q/d impacts that are similar, if not greater than, BART sources that will be required to add controls. The methodology to calculate visibility improvements noted in Table 9.9 are not explained in this section but appear to be some calculation of changes in the long-term metric of the 20 percent worst visibility days. These sources likely contribute to higher impacts on a daily basis, and a reduction in their emissions would be part of a broad strategy to reach natural conditions at the Class I areas. As such NDDAQ should examine the total improvement from the suite of sources as part of its reasonable progress assessment, not a simple unit by unit approach.

The assessment of non-air quality impacts on page 181 in the draft SIP does not address the substantial human health benefits associated with reductions in fine particulate concentrations resulting from additional control of SO_2 and NO_X emissions from Coyote and AVS since they would become the newest and highest emitters of these pollutants after implementation the SIP as drafted.

The decision on additional point source controls would be better informed by analysis of the how the emissions from sources within the State contribute to nitrate and sulfate concentrations in Class I areas, both inside and outside of the State, in the baseline period compared with the model projections in 2018. If BART controls on stationary sources as well as expected reductions from Federal mobile source, small engine, and fuel requirements would achieve a reduction that, had all other contributing States and other regions met similarly, would put the total aerosol extinction on the uniform rate of progress path, then the State could better support a limited approach to additional controls in this first planning period. However, based on our review of the information supplied in the draft Plan and its appendices, we believe there are cost-effective controls for the Coyote and AVS facilities that should be implemented under the reasonable progress provisions.

Section Ten: Long-Term Strategy

We appreciate that a description of the State's smoke management activities regarding anthropogenic fire is referenced in the Plan. We agree that current rules are sufficient to address the small extinction associated with this component. We also appreciate the Plan referencing conservation tillage as an approach to reduce windblown dust.

On Page 184, there is discussion of the reduction in sulfur dioxide emissions from the R.M. Heskett Station No. 2. As noted earlier, we believe this facility is subject to BART and should be assessed under the BART provisions. In addition, the reduction in emissions reflect a 21 percent reduction from current emissions. The 70 percent coal-to-stack removal cited in the draft Plan implies a greater reduction from current emissions.

We request that NDDAQ include in the Long-Term Strategy a linkage between the prevention of significant deterioration program and its assessment of visibility impacts and the Regional Haze Plan in the SIP. This will ensure that new sources are reviewed in a manner that does not jeopardize the reasonable progress goals established by this Plan.

Section Eleven: FLM Consultation and Coordination

We appreciate the ongoing efforts of NDDAQ to consult with the federal land management community.

Section Twelve: Public Participation and Review Process

No comment